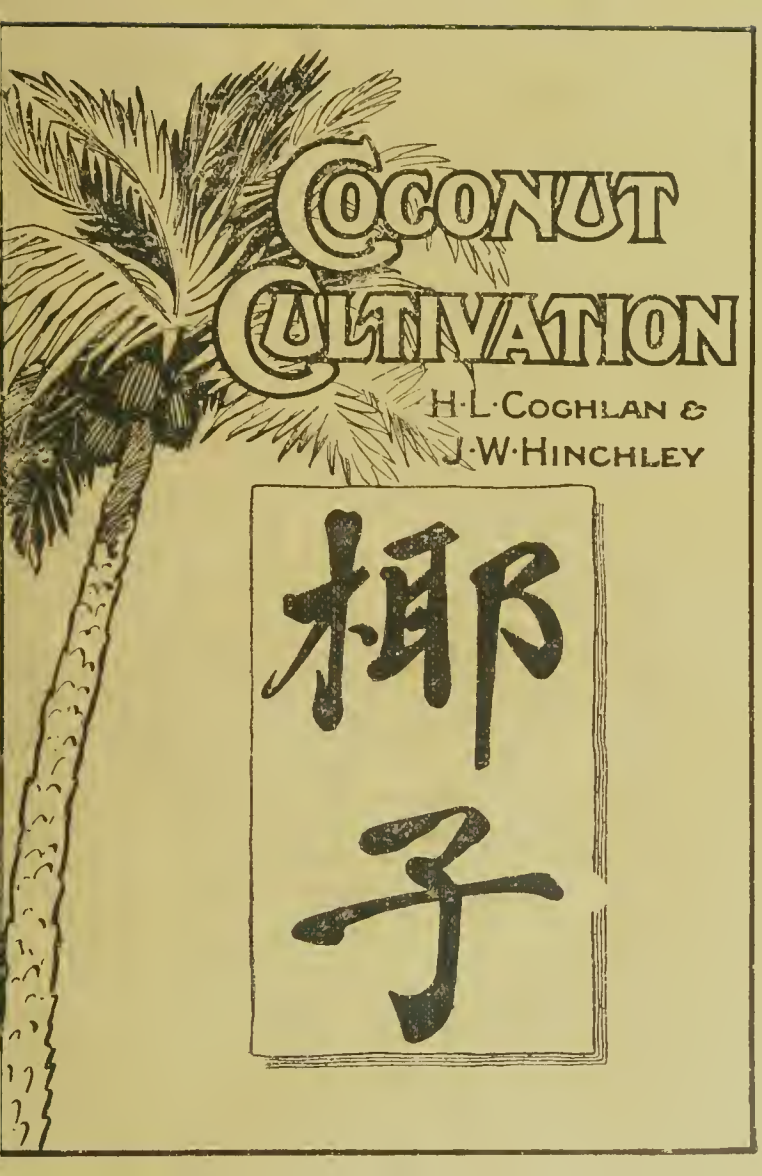

COCONUT CULTIVATION

H·L·COGHLAN &
J·W·HINCHLEY

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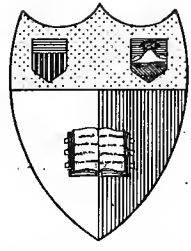

COCONUT CULTIVATION AND PLANTATION MACHINERY

PLATE I.

[*Frontispiece.*

INFLORESCENCE OF THE COCONUT PALM.

The spathe in three stages.

COCONUT CULTIVATION
AND
PLANTATION MACHINERY

BY
H. LAKE COGHLAN
(OF SINGAPORE AND JOHORE, MALAY PENINSULA, AND THE BRITISH AND ASIATIC AGENCY, LTD., LONDON)
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JOHORE DELEGATE TO PLANTERS' ASSOCIATION OF MALAYA
AND
J. W. HINCHLEY
ASSOCIATE ROYAL SCHOOL OF MINES, WHITWORTH SCHOLAR, FELLOW OF THE CHEMICAL SOCIETY, LECTURER AT THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY LONDON, ETC.

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PREFACE

LIKE others interested in tropical agriculture, the Author, since his arrival in England, has had many inquiries for coconut propositions, either in the shape of plantations, nuts, or copra, and for information on present and future outputs. He was also pleased to receive a request from the editor of the *Financial News* (Empire Section), to write something on the subject, which is reproduced here.

The first article adopted a precautionary tone, and the second advocated—in addition to planting from the beginning—an agricultural bank, for which in Malaya there is a great field.

Were a capitalist, interested in copra, asked to put up money for the planting of the coconut, he would at once scout the idea. If this attitude be commonly adopted, and the abnormal present-day requirements continue, what is to happen to the industry when the manufacturer is restricted to present cultivated areas ?

For example, a material like copra costs from £8 to £9 per ton to produce; it is selling for £30, and consequently derived products, namely, margarine, soap, candles, confectionery, and fats

for human consumption become proportionately dear.

That the outputs from present supplying areas will be further restricted is known from the fact that about half of present yields goes back into the ground as seed nuts for new areas; a quarter is used for local consumption; and only the remaining quarter is available for foreign markets.

There is no other course open to the foreign consumer than to protect himself against famine prices by planting *ab initio*.

Furthermore, be it noted, a paternal Government now prohibits by law the Malay in the Federated Malay States from parting with his holdings as being against his best interests; and it is with great difficulty and uncertainty that a property can be obtained in the Dutch Indies, where the proposed owner must be a Dutchman; and in the case of a British company a directorate in Holland is necessary. Much time is taken up in securing the official signatures to a concession, and until the Queen's seal is affixed to it, a Dutch grant is said to be of little commercial value. The country where the Government extends a hearty welcome to the capitalist planter is British North Borneo. Its possibilities as a coconut centre are great, and are generally acknowledged to be as good, if not better, than in any other tropical country, the Philippines included. Land near the sea, complying in every way with the requirements of the palm, is to be had on Government grant at an annual quit rent of 50 cents = 1/2 per

acre, for the first six years, and thereafter $2 = 4/8 per acre. Government is steadily supplementing labour by the introduction of Chinese coolies, who are born agriculturists.

Though confined principally to Malaya, this little book may be widely useful. The author does not pose as an authority, but merely as one who, during twenty odd years in the Tropics, has gleaned useful information which may assist others. Authors of other books on the industry are generous enough to admit that they have not a monopoly of phrases, ideas, and suggestions, but it is but fair to mention that, in compiling this book, a wide range of evidence has been consulted as a check on the Author's ideas. Special acknowledgments are due for quotations and information taken from their respective publications, to the Government Inspector of Coconuts in the Federated Malay States; to Messrs. Ferguson, of Ceylon; to Alford Nicholls, Esq., the Director of Agriculture to the Federated Malay States, and to H. N. Ridley, Esq., and the Imperial Department of Agriculture for the West Indies.

H. L. C.

THE BRITISH AND ASIATIC AGENCY, LTD.
39, LOMBARD STREET, LONDON, E.C.

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Dollars into Sterling at 2/4.

Amount.					Amount.			
$ cts.	£	s.	d.	dec.	$	£	s.	d.
0 01	0	0	0	28	40	4	13	4
0 02	0	0	0	56	50	5	16	8
0 03	0	0	0	84	60	7	0	0
0 04	0	0	1	12	70	8	3	4
0 05	0	0	1	40	80	9	6	8
0 06	0	0	1	68	90	10	10	0
0 07	0	0	1	96	100	11	13	4
0 08	0	0	2	24	200	23	6	8
0 09	0	0	2	52	300	35	0	0
0 10	0	0	2	80	400	46	13	4
0 20	0	0	5	60	500	58	6	8
0 30	0	0	8	40	600	70	0	0
0 40	0	0	11	20	700	81	13	4
0 50	0	1	2	00	800	93	6	8
0 60	0	1	4	80	900	105	0	0
0 70	0	1	7	60	1,000	116	13	4
0 80	0	1	10	40	2,000	233	6	8
0 90	0	2	1	20	3,000	350	0	0
1 00	0	2	4	00	4,000	466	13	4
2 00	0	4	8	00	5,000	583	6	8
3 00	0	7	0	00	6,000	700	0	0
4 00	0	9	4	00	7,000	816	13	4
5 00	0	11	8	00	8,000	933	6	8
6 00	0	14	0	00	9,000	1,050	0	0
7 00	0	16	4	00	10,000	1,166	13	4
8 00	0	18	8	00	20,000	2,033	6	8
9 00	1	1	0	00	30,000	3,500	0	0
10 00	1	3	4	00	40,000	4,666	13	4
20 00	2	6	8	00	50,000	5,833	6	8
30 00	3	10	0	00				

Sterling into Dollars at 2/4.

Amount.					Amount.			
s.	d.	$	cts.	dec.	s.	d.	$	cts. dec.
0	1	0	03	57	0	10	8	14 29
0	2	0	07	14	1	0	8	57 14
0	3	0	10	71	2	0	17	14 29
0	4	0	14	29	3	0	25	71 43
0	5	0	17	86	4	0	34	28 57
0	6	0	21	43	5	0	42	85 71
0	7	0	25	00	6	0	51	42 86
0	8	0	28	57	7	0	60	00 00
0	9	0	32	14	8	0	68	57 14
0	10	0	35	71	9	0	77	14 29
0	11	0	39	29	10	0	85	71 43
1	0	0	42	86	20	0	171	42 86
2	0	0	85	71	30	0	257	14 29
3	0	1	28	57	40	0	342	85 71
4	0	1	71	43	50	0	428	57 14
5	0	2	14	29	60	0	514	28 57
6	0	2	57	14	70	0	600	00 00
7	0	3	00	00	80	0	685	71 43
8	0	3	42	86	90	0	771	42 86
9	0	3	85	71	100	0	857	14 29
10	0	4	28	57	200	0	1,714	28 57
11	0	4	71	43	300	0	2,571	42 86
12	0	5	14	29	400	0	3,428	57 14
13	0	5	57	14	500	0	4,285	71 43
14	0	6	00	00	600	0	5,142	85 71
15	0	6	42	86	700	0	6,000	00 00
16	0	6	85	71	800	0	6,857	14 29
17	0	7	28	57	900	0	7,714	28 57
18	0	7	71	43	1,000	0	8,571	42 86

COCONUT CULTIVATION

(COCOS NUCIFERA)

INTRODUCTION

THIS book is intended as much for the Chinese and native planters in the East as for the European, and the aim of the author is to interest them more deeply in the cultivation, without wearying them by excessive quotations from other writers, or by voluminous statistics in regard to market prices. These change rapidly, and published records soon become out of date, and in such matters, each country is a law unto itself; to an intelligent mind all that is required, in connection with an industry, is a framework or foundation to which can be added a superstructure modelled on local conditions, requirements and comparisons.

The cultivation of the coconut is not in the experimental stage—it is certain and lasting, and as it has assured comfort and prosperity to millions of the human race in the past, so in the future will it continue to do, and to a far greater extent.

That the planter will continue to score considerably over the manufacturer and consumer is beyond any doubt, for all markets, now short

of animal fats for human consumption, turn for their requirements to the coconut, and well may it be said that "he who planteth a coconut tree doeth a virtuous act."

Out of the hurricane belt it is one of the safest things in tropical agriculture, and the history of the palm makes this incontrovertible. Nothing that grows on earth has so many uses for humanity as this wonderful tree. To the native it is food, drink, clothes, house, and many other important necessaries of life.

The roots furnish—a remedy for fevers.

The trunk—wood for house-building, boat-building, plantation bridges, furniture (with beautiful grain).

The leaf—thatching, attaps, baskets, torches, hats, mats, sieves.

The stalk—combs, firewood.

The flower and cut flower stalk—a medical astringent, toddy or palm wine, arrack, jaggery sugar, vinegar.

The husk—coir for ropes, mats, cordage, brooms, bedding, brushes, paper pulp.

The shell — lamps, fuel, drinking vessels, kitchen spoons, charcoal, rubber latex cups.

The kernel or albumen, commercially known as copra—oil, cattle feed, nut butter, soap, food products, candles.

The milk—a delicious beverage.

* * * * *

From comments heard from day to day there would appear to be a grave element of danger to

the capitalist about to enter the field of tropical agriculture, but this supposed danger is not so formidable as is assumed. Nevertheless, there are pitfalls which should be avoided, and as the coconut industry in the future, is to play so prominent a part in the financial world, the note of warning given in the following articles, written by the author, which appeared in the *Financial News* (Empire Section) of June 12 and 19 and July 3, 1913, will not be out of place.

Reprinted from "Financial News," June 12, 1913.

"Remarkable attention is being directed toward the coconut industry, and on all sides one hears of the boom that is at hand. The company promoter is busy preparing his nets for the promised good time, and the ex-tropical man will, as usual, have an option ready, or know of a friend who has one. It may not be out of place therefore to put on record a few remarks of a precautionary nature.

"Malaya — the successful rubber and tin country—is also an ideal land for the cultivation of the coconut, its equable tropical climate; its rich alluvial soil; its plentiful and evenly-distributed rainfall; and its ozone-laden breezes all making for rapid and prolific growth. It must be remembered, however, that in the past, Europeans have not given this particular cultivation the same attention that has been devoted to rubber and coffee, and consequently the industry has been confined almost entirely to the efforts of

the natives. This will account for most of the coconut estates in Malaya being in the hands of Malays or Chinese. The plantings are more or less limited to the Kampongs, or villages, in regions near the sea, or on neighbouring islands. The titles usually take the form of mukim permits, or short agricultural leases, for blocks often as small as five acres, and, in order to obtain an estate of any magnitude, it may be necessary to embrace 200 or 300 holdings. This is mentioned to show that at the present time in Malaya, even though in the whole territory it is estimated there are about 150,000 acres under coconuts, it is difficult to find a plantation in bearing of 500 acres and upwards held under single ownership, or under a modern title readily negotiable. The Government does not look with favour upon natives parting with their holdings, and even when one has overcome the difficulty of getting actual owners' (not squatters') signatures to a sale agreement, official transfer may be delayed, or even refused, on the ground of non-compliance in the past with cultivation covenants, or more likely of quit rents in arrear. Therefore, it behoves one to move cautiously when dealing with schemes sent here for flotation.

"Before parting with any cash, a few pertinent questions to ask are:—

"(1) Is the estate in one block? if not, in how many blocks, and are they contiguous?

"(2) How many owners are there?

"(3) If native-owned, have signatures been

attested by the Penghulu, or native headman, of the district?

"(4) Was each owner given a consideration?

"(5) Has the proposed sale the approval of the British Resident of the State?

"The questions satisfactorily answered, one might proceed to obtain the expert report: but before this cost is incurred vendors should be in a position to state, on independent evidence, the following:—

"(1) Age of trees; number per acre.

"(2) Nature of soil; if peaty, whether it has been limed.

"(3) When and how manured.

"(4) What precautions have been taken against red beetles.

"(5) Is there evidence of trees defoliated by caterpillars.

"(6) If there are catch crops, particulars of them and revenue.

"(7) If there are squatters, what rights or sub-leases they have.

"(8) The average nuts per tree per picking, number of pickings per annum, evidenced by sales of nuts or copra.

The Expert

"In choosing an expert to make a report, a London buyer would do well to bear in mind that in Malaya there are few planters intimately acquainted with the coconut industry, and fewer

still who can speak from personal experience in the actual planting of the nut, from seed to copra. As planters, however, they have had the experience of local conditions; of soils and manures; of the comparisons of one estate with another; and they should be judges of areas. For the remaining details which usually go to make up a report, they turn, as every one does, to Chamber of Commerce statistics and published handbooks. Regarding the latter, too, a word is necessary. Recently there was published in London a remarkably well-compiled book on the coconut industry. It contains a wonderful collection of useful information, but does not embrace Malaya, where the best nuts are grown. It is compiled generally from Government statistics, and seems to leave little untold. In it an estimate is given, as an extract 'from a Government report,' on the cost of planting and bringing into bearing an area of 500 acres; and the cost per acre at the end of the sixth year is put at £13. Now, this cannot be done in Malaya; for official figures there, put the cost at about £25 per acre. This figure is certainly on the high side, as, in the opinion of experienced planters who in coconuts dispense with fancy work, £20 per acre should not be exceeded.

Stocks of Copra

"Another point to be remembered in connection with this industry is the fact that unlimited

supplies of copra are not waiting in Malaya to be bought cheaply from inexperienced natives. Copra sales are largely in the hands of Chinese produce dealers, who are astute men of business. They have English-speaking clerks, are familiar with market prices, and are accustomed to receive daily bids for their produce from European firms representing big British and continental trading companies. People on this side, therefore, should not be misled by haphazard statements regarding untold quantities of copra only awaiting capital to purchase it. Malaya came through the rubber boom without a blemish. Speculators may have lost money in shares and crazy finance, or through irresponsible valuations and reports; but one cannot recall a case of deliberate misrepresentation. The country may rightly be termed the Land of Promise, and now that a few words of warning have been put on record we may turn to the attractive side of the subject.

Coconuts as an Attractive Investment

"There are large tracts of land, rich in alluvial soil, in Malaya, well suited for coconuts, and these await the advent of enterprising capitalists. The industry itself is but in its infancy, and is bound to expand on the introduction of more enlightened methods for the preparation of copra and the extraction of oil; and the demand for fats for human consumption (such as

margarine or nut-butter), and the enormous requirements of the soap trade, to say nothing of the products used in the manufacture of biscuits, confectionery, cattle food-cake, coir fibre, and yarns, are ever increasing.

"A foreword written recently by Sir William Lever, one of the greatest soap manufacturers, says: 'I know of no field of tropical agriculture that is so promising at the present moment as coconut planting, and I do not think that in the whole world there is a promise of so lucrative an investment of time and money as in this industry.'

"At present the exports from Malaya are:—

Coconuts, value	$ 305,452
Coconut oil	2,218,436
Copra	18,429,954
Total	$20,953,842

or about £2,500,000 sterling. This is bound to increase enormously in the near future, and in British Malaya—'the Golden Chersonese,' as it is called—is held out the promise of fortune beyond ordinary conception; but one can only go there on somewhat prepared lines, and with capital, not necessarily large, but sufficient to deal with at least 500 acres of land. Some London rubber agencies have as many as a hundred applicants, mostly public-school boys, waiting for a vacancy to occur out East: men now recognize that the old professions in England are played out; that for young fellows of

stability and ambition new fields must be found. Planting attracts them because of its open-air life, its constant and varied occupation; in leisure moments, excellent shooting, and, in due course, splendid returns on their outlay.

The Investment and its Security

"If only capital could be found for these waiting men a great impetus would be given to one of the biggest industries the world will ever see, and the enterprising financiers would have a new field for their energies and security for their investment. The natural question arises, How would a financier be secured? Well, to start with, a young man taking up the coconut industry would require to find some cash himself, and in his own interests as well as of those who are subsequently to help him, his capital should be the initial outlay, or cost of the first year's development; in the succeeding years he would expect financial assistance. We will assume that 500 acres are to be put under coconut cultivation.

Estimate

"The cost in the first year for land, felling, clearing, planting, and buildings would be about £4,500: in the second, third, fourth, fifth, and sixth years, £1,500 each = £7,500; total, £12,000.

"Therefore, at the end of the sixth year, the young planter will have invested £4,500, and have received financial support for £7,500, the

latter forming a first charge on the property, now of a value considerably higher than the total sum spent on it. Let us now investigate the return this should give the investors.

REVENUE FROM AN ESTATE OF 500 ACRES.

Trees planted 30 ft. by 30 ft. = 48 trees to acre.
4,000 nuts = 1 ton copra.

*6th year—	Per ton.	Total cost price.	Per ton.	Total selling price.
	£	£	£	£
10 nuts per tree ... = 240,000 nuts ... = 60 tons copra ...	9	540	25	1,500
7th year—				
30 nuts per tree ... = 720,000 nuts ... = 180 tons copra ...	9	1,620	25	4,500
8th year—				
40 nuts per tree ... = 960,000 nuts ... = 240 tons copra ...	9	2,160	20	4,800
9th year—				
50 nuts per tree ... = 1,200,000 nuts ... = 300 tons copra ...	9	2,700	20	6,000
10th year—				
50 nuts	9	2,700	20	6,000
		£9,720		£22,800

Net profit in five years £13,080 on invested capital of £12,000.

1st dividend	8%
2nd ,,	24%
3rd ,,	22%
4th ,,	27½%
5th ,,	27½%

These dividends improve with price, of course, and as it will be many years before supplies will exceed demand, £20 per ton for copra is considered conservative. Nothing is included for profit on by-products.

* On rich soils trees often fruit in the third and fourth year, but against these must be reckoned the trees that fail to fruit till the eighth year.

"Surely here is sufficient security and return for an investor.

Wanted—An Agricultural Bank

"The individual, however, does not generally welcome an investment which means a lock-up of capital for a number of years, and therefore, on a large scale, much help cannot be expected from the public as individual investors. What is really wanted is an agricultural bank, with a Government or semi-official backing—a bank that could raise money at low rates, and lend it to the planters at 7 to 8 per cent. There is enormous scope for such an institution, as Malaya is at present without one. There are exchange banks, certainly; but plantation loans and real estate mortgages are beyond their charter. The F.M.S. Government from time to time assists planters with loans; but the amount available is small in proportion to the requirements, and the relief given is consequently very limited.

An agricultural bank would have a fine field in which to operate, and if it encouraged the small depositor it would at the same time be establishing a feeling of thrift at present almost unknown in Malaya among the natives. There is, of course, in the Straits a small post office savings bank, but it is little understood, and the ordinary individual has not the slightest knowledge of how its funds are administered—certainly it is not for the development of agriculture, now the backbone of the colony.

"In the Straits and F.M. States there is a native population of 2,650,000. The total imports and exports of the Straits amount to £86,324,495 and the F.M.S. to £21,324,678.* Extreme poverty, as seen in the West, is there unknown. Clothing and food are cheap and trade generally good. Educate these people to save a portion of their earnings by an easy deposit system, with a bank that would in turn lend to the agriculturist, native or European, and a perfect system of industrial finance is established.

Timber

"The Eastern States of Malaya, including Johore, offer some attractive fields to the capitalist planter in concessions that are well timbered, and such timber is readily saleable in China, and at a good profit. While it is true that the European may not find the timber business as profitable as a Chinaman would, it is a point worthy of note that in the Eastern States—Johore in particular—Chinese contractors are to be found who, in exchange for the timber they remove, will fell, clear, and plant up an estate; or will hand over an estate planted up in exchange for a first and second light catch crop. The Chinaman, however, often tries to get the better of the bargain, and though such arrangements frequently lead to trouble, many are successful, and, with watchful handling, prove most economical.

* Figures in 1911.

Catch Crops

"Catch crops, though not generally favoured, in that they are apt to take too much out of the soil, often help considerably in the waiting years. Among the best of these are Robusta coffee, limes, bananas, and native fruits. Indigo, with its usefulness in green manuring the permanent cultivation, is a paying catch crop, but needs a considerable amount of extra capital at the outset.

Present-Day Prices

"The price asked for coconut estates in bearing ranges from £30 to £60 per acre, and the majority of them have not cost more than £18 per acre, if that, to bring to the fruiting stage. Estates in good condition will no doubt command such prices, but to investors who are interested in the industry, apart from speculation and company promoting, the best advice that can be offered is to start from the beginning. Land terms for coconuts are more favourable than those for rubber. The industry is popular with the real native of the country—the Malay—and he thoroughly understands it. Thus local labour is available where often for other agricultural pursuits indentured labour—Tamil or Chinese—would have to be imported. Adverting to the question of waiting six years for a return on one's investment, it may be of interest to mention

that six years before the rubber boom the writer had much difficulty in persuading what is now one of the biggest and most prosperous rubber concerns in Malaya to take up the cultivation of that commodity. He refers in particular to continental interests, which came into existence in the early days of rubber, and were highly successful. The same people are now planting 'the Consols of the East' in the Malay Peninsula; and in the light of modern requirements, we see that the coconut industry is in its infancy and that it is on the eve of greater development.

"The important economic features of tropical agriculture are perfectly evident to the British capitalist, and it is for him to consider whether he will be early in the field of this great commercial venture to commence planting operations at once, patiently to await returns, or allow his continental opponent to forestall him. To one who has lived in Malaya upward of twenty years, and who has watched its development year by year and appreciates the wonderful future the country has before it, it is difficult to understand why any persuasion is needed to enterprising Britishers at home to remove their capital from the uncertainties of strikes and the ever-increasing cost of labour to a land of lucrative investments with perfect security—one free, practically, from the results of modern legislation as known in the Old Country.

"We carefully note the efforts of Germany in

her desire to cope with us in armaments, but do we follow her as closely in her scientific pursuit of tropical produce? As an instance may be mentioned wolfram, another product of Malaya which is scarcely known in England, whereas Germany has special agents in the Straits who buy up every ounce that is offered them. The latest official statistics show that for 90 tons of this metal shipped to the United Kingdom, 220 tons were sent to Germany, and the use of this, in particular, is for the hardening of steel armour plates. We are apt to think that everything worth having must, in the first place, come to London, the so-called home of capital; but capital will follow successful enterprise anywhere, and in many branches of commerce our neighbours appear to be getting ahead of us. It is hoped, therefore, that these remarks on so great and promising an industry may serve to stimulate the desire to foster and encourage it, and in the work there is, apart from individual gain, a building up of Imperial interests which can never fade away."

Prevention of Alienation of Native-Owned Lands

The following letter by the author appeared in the *Financial News* of July 3, 1913:—

"Adverting to an article which I recently contributed to your columns in regard to the

coconut industry in Malaya, it may be of interest to mention that the last mail from the East brought news that the Government contemplates bringing in an enactment forthwith for securing to the Malays their interests in land, and the objects and reasons of the Bill now before the Federal Council are set out as follows :—

"'The object of this draft is to prevent the passing of Malay land holdings into the possession of foreigners. The reason for such legislation is found in the recently increased demand for agricultural land in the Federated Malay States, and the temptations thus held out to Malay landowners to dispose of their lands contrary to what the Government believes to be their best interests.'

"The note of warning I gave in my first article was to this effect."

H. L. C.

CHAPTER I

SOIL

HAVING reviewed the situation in general, attention is now directed to the actual work of cultivation, in connection with which this manual is particularly concerned.

The different branches of the industry are treated under separate headings, and in natural sequence soil should claim first attention.

Soil.—Low alluvial flats near the mouth of rivers, which are occasionally subjected to light inundations, are best suited for the cultivation of the coconut, the alluvial loam usually being rich and deep.

The climate should be tropical and preferably maritime, for the palm delights in the saline atmosphere of the sea. Some inland planters make up for the lack of this by putting salt with the seedlings when planting out. Salt manuring, however, is a debatable question, for it is shown beyond doubt that given a calcareous soil, coconuts grow as well inland as near the sea, the presence of lime in the ground being an essential.

Over low-lying lands peaty soil often exists,

and provided the land has been well turned previous to being planted, drained and limed, to destroy the deleterious acids which have been formed owing to stagnant water lying on or close to the surface for a long period, the trees thrive very well indeed.

Land under lalang grass is to be avoided, more especially such large abandoned tracts as have been previously planted up with tapioca or gambier. Also to be avoided are peat (unless thoroughly drained and limed), inert and heavy retentive soils, and hill land with an inclination greater than one in fifteen.

On the question of soil the Director of Agriculture to the Federated Malay States, in his 1911 official report, writes as follows :—

" One point is clear and that is that conditions in Malaya are quite different from those obtaining in other countries—for example, the best plantations here are those on heavy clay land, while the usual idea is that coconuts thrive best in light soils. The majority of plantations here are on the flat low-lying lands near the coast."

Soils in order of merit are placed thus :—

1. Alluvial flats near streams.
2. Deep brown gravelly loam.
3. Deep loamy sand.

Examination of Soils.—Weigh out a quarter of a pound of the earth after it has been well dried, boil it for a short time in a pint of water

and then pour it into a glass vessel. A piece of blue litmus paper should then be put in, and if the paper turns to a red colour, it shows that acid humus is present in the soil, *and that lime is necessary to counteract the acidity.* More water is then to be added, the whole is to be well stirred, and the muddy water is to be carefully poured off into a large vessel, care being taken that none of the sand which settles at the bottom be lost. The sand is then to be stirred up with fresh water, which is again poured off into the larger vessel. And this is to be done several times until the sand becomes quite clean and free from mud. The contents of the larger vessel are to be allowed to remain for several hours until the fine mud settles to the bottom, when the clear water is to be carefully poured off. The sand and the mud should then be dried and weighed separately, when, by comparing their weights with a quarter of a pound, the proportion of sand and earthy matter in the soil can be ascertained. To discover the presence of lime in a soil, it is only necessary to pour a little hydrochloric acid upon it; this will cause effervescence if there be any carbonate of lime, and the degree of the effervescence will give to an experienced observer a rough indication of the quantity present. To ascertain the exact quantity of lime, however, the acid must be allowed to remain some time on the soil, and then a solution of ammonia must be added. All the lime will, by this

means, be dissolved out of the soil, and it will remain in the liquid, from whence it can be thrown down by a solution of oxalate of ammonia. But this process can only be attempted by a person having some knowledge of chemistry. The proportion of vegetable matter, or humus, in the soil is ascertained in a rough manner, by heating for an hour to a red heat a given quantity of thoroughly dry earth in an iron or clay vessel, when the vegetable matter will be burnt off. The earth is then to be cooled and weighed, and the loss in weight will give the proportion of humus in the soil (Alford Nicholls).

Classification of Soils (after Schübler and Wrightson).—

Classes.	Sub-Classes.
I. Clay or argillaceous soils. (Over 50 per cent. of clay.)	1. With lime. 2. Without lime.
II. Loamy soils. (30 to 50 per cent. of clay.)	1. With lime. 2. Without lime.
III. Sandy loams. (20 to 30 per cent. of clay.)	1. With lime. 2. Without lime.
IV. Loamy sands. (10 to 20 per cent. of clay.)	1. With lime. 2. Without lime.
V. Sandy soils. (Over 70 per cent. of sand.)	1. With lime. 2. Without lime.
VI. Marly soils. (5 to 20 per cent. of lime.)	1. Clayey marl. 2. Loamy marl. 3. Sandy loam marl. 4. Loamy sand marl. 5. Vegetable marl.

Classes.	Sub-Classes.
VII. Calcareous soils. (More than 20 per cent. of lime.)	1. Clayey calcareous soil. 2. Loamy calcareous soil. 3. Sandy loam calcareous soil. 4. Loamy sand calcareous soil. 5. Vegetable calcareous soil. 6. Pure calcareous soil (without clay or sand).
VIII. Vegetable soils. (More than 5 per cent. of humus.)	1. Clayey humus. 2. Loamy humus. 3. Sandy humus. 4. Bog or peat.

Each of the first twenty-one sub-classes are again sub-divided into three groups according to amount of humus in the soil, viz. :—

1. Poor. If they contain less than ½ per cent. of humus.

2. Intermediate. If they contain from ½ to 1½ per cent. of humus.

3. Rich. If they contain from 1½ to 5 per cent. of humus.

Rainfall.—From 60 to 80 inches per year evenly distributed is what suits the coconut tree best, though it will thrive well on less—but not below 50—if the soil is free and the roots can travel easily in search of water; more than 100 inches of rain is said to produce more leaf and less fruit.

CHAPTER II

PREPARATION OF THE LAND

Felling.—If the land is old forest or with strong secondary growth, the trees, after felling, should be entirely burnt off. This should take place in the dry months—a month or so before the rainy season. About three weeks after felling, fire should be set to the fallen jungle, and this should not be deferred till all the leaves have fallen or the undergrowth has made some progress; a good burn saves much after labour. Above all things, lalang grass must be kept out of the clearing. It not only retards growth, but when long and dry is an ever-present danger by fire. The careless coolie and the discarded match amongst lalang have cost the planter many thousand dollars in the past.

Stumping.—There ought not to be any question in a planter's mind as to the advisability of rooting up all tree stumps, for such work has for its object the prevention of the development of fungi, termites, and other insect pests. These pests attack living or dying trees, and the danger lies in the half-dead trees on the estate after the burn. Some planters hold that

A BAD BURN. [*To face page* 22.

stumping should be done at the outset; others advocate a year or two after planting; whilst some, on the score of expense, take the risk of disease and allow the stumps to rot away.

The ideal plantation is, of course, freed from stumps and fallen timber before planting is begun; the real danger from disease is during the first year. After that time the stumps or timber have reached such a state of decay as to be immune from the attacks of pests, except beetles, and can then be left to rot away.

Comparative estimates of clean-cleared and non-clean-cleared estates put the latter at a disadvantage in the first revenue years, and the cumulative loss through non-clean clearing is estimated at about 10 per cent., or in other words, what the non-clean-cleared estate saved in initial expenditure, it loses in revenue in the early fruiting years, whereas the clean estate recovers the first cost of stumping in extra produce, and it is a year or two before it is overtaken by the originally non-cleared estate.

Lining.—There are differences of opinion as to distance at which trees should be planted, but the popular space is a square of 30 feet by 30 feet, which gives forty-eight trees to the acre. This distance allows for the interplanting of catch crops, and moreover, the palm branches, which at maturity are 16 feet to 18 feet in length, do not interfere to any extent with those of a neighbouring tree.

Holing.—After the ground is thoroughly cleaned, the pits for planting out the young plants should be dug. The larger the pits are the better, but a 2 feet cube is generally considered sufficient. All the soil removed from the pits should be replaced by good surface soil to within 6 inches of the top. When this work is finished, the young plants, which should be from five to seven months old before being removed from the nursery, may now be placed in these holes, leaving the nut of the seedling about 6 inches to a foot below the surface and just slightly exposed. When the plant has come well away, say with about a dozen well-grown leaves on it, the holes should be filled to the top with good surface soil.

The most favourable seasons in Malaya for planting are during April and May, and again from the middle of September to the end of October.

Drainage.—Where the land is undulating in even slopes, little or no drainage is required, but on the low flat alluvial soil, drainage is of considerable importance, and it is always advisable in this case to have drains dug all round the proposed clearing before felling the jungle or secondary growth. This is especially the case where the soil is of a peaty nature, and here, after the clearing is burnt off, it is of advantage to keep the land exposed for as long as possible, say at least six months, during

which time attention should be paid to further drainage, if necessary.

It is evident that drainage is a most important factor, and should be specially looked into when the location of a proposed plantation is being selected. The coconut tree is probably less affected by sour land than most tropical plants. At the same time, stagnant water must sooner or later have a very deteriorating effect on the trees; in fact, some of the native holdings in the Federated Malay States have suffered considerably through inattention to this point.

CHAPTER III

SEED NUTS, ETC.

Seed Nuts.—These should be the produce of healthy heavily-bearing trees, of medium age, *i.e.* about thirty years; large-sized roundish nuts, ripe but not dry, of a red, brown or green colour, with a thin husk and the three longitudinal ridges on the husk not prominent.

It is an advantage not to plant the seeds for a month or so after they have been picked so that the outer skin may get thoroughly dry and the husk be allowed to harden.

Nuts selected for seed should be carefully examined to see that they are not damaged in any way.

The planter cannot exercise too much care in the selection of seed nuts. Weak parents produce offspring with a tendency to weakness, whereas in planting good seed from strong mature good trees, a palm is produced which should prove a robust column of wealth production for over a hundred years. The nuts give heavy thick-fleshed copra, and the husks full quantities of coir. When gathering for seed, nuts should be lowered from the tree and on no account allowed to drop. A planter as far as

PLATE III.

SEEDLINGS, READY FOR PERMANENT FIELD. [*To face page* 26.

practicable should personally supervise the collecting of his seed nuts and thus become acquainted with their family history.

Nurseries.—The land selected for the nursery ground should be of rich soil, light and free, prepared by trenching 18 inches deep, formed into beds with 2 feet intervals; the earth should be removed to a depth of 6 inches and piled in the intervals; pack the nuts close together in the beds with the stalk ends up; fill in spaces between nuts with earth removed, leaving the crown only above the surface; water well to settle the soil round the nuts and shade beds with grass or straw. The natives are alive to the necessity of watering plants, and they have a pretty adage, specially applied to this part of the cultivation. It is: "Water me continually during my youth and I will quench thy thirst abundantly during the whole course of my life." A thin layer of sand tends to prevent the ground getting sodden, which in turn causes roots to rot.

Native Method of Germinating Seed.—Seed nuts are tied in pairs by a portion of the outside husk and then hung from a stretcher supported at a height of 6 feet from the ground in a sheltered spot. Leaves and roots soon appear, and the young plants are ready to be removed for planting out at the customary period.

From the nursery bed the seedlings, at the age

of five or six months, are transplanted to the permanent field; some planters suggest an intermediary stage or advanced nurseries in good selected ground near water. The seedlings are put in at 5 feet apart, and high cultivation is devoted to them until their vigorous growth stands assured. They are then finally transplanted to the main fields. While it is true that transplanting at any stage is a check on growth, it must be remembered that the coconut is less thrown back by transplanting than any other plant.

The disadvantage, if such there be, lies not so much in the retardation from transplanting as in the extra cost incurred; but against the latter is placed more rapid and prolific growth.

It will be found that all seed nuts do not germinate, or that some produce weakly plants, which makes it advisable to sow fully 50 per cent. more nuts than permanent plants desired.

An occasional watering is necessary in the dry months.

Clean Weeding.—Why should this be important during the first four years? The simple reason is that during that period the roots will have undisputed possession of the soil and have all the available plant food at their disposal during tender years. In late years the shade created by the trees will keep in check all weed growth.

Cultivation.—After the seedlings have been

transplanted and have become firmly rooted in the ground, very little cultivation is required beyond keeping the land free from weeds, particularly round the young tree. They should be circled and dug round every three months with the native "changkol" or hoe, and ploughing over the whole land periodically to a depth of 9 inches will be found very beneficial.

For stirring up the soil round a tree, or for manuring, the best implement is the Assam fork; it is spade-shaped with strong steel prongs, but it has the hoe or changkol handle, and the body action in using it is the same as with the popular changkol.

As the trees advance in age, the radius of the circle dug up should be increased—for one-year-old trees, 2 to 3 feet from the stem of the tree will be found sufficient; for two-year-old trees the radius should be increased to 4 feet, and so on; the circle dealt with in this way, when the tree reaches maturity and is in full bearing, is about 8 feet from the stem.

These remarks refer particularly to the stiffer land; where the soil is loamy and rich, hoeing and ploughing may perhaps be unnecessary, or not until the trees are much older.

"The question of the cultivation of coconuts is, to my mind, still an open one. Does clean weeding, as commonly practised on rubber estates, pay best? Is it better to keep clean an 8-foot circle round the trees and allow the weeds to grow (always excluding lalang), or should

the intermediate land be ploughed or forked? Should a leguminous cover crop be grown? Is any manurial treatment required beyond an occasional dressing of bullock manure? I would not wish to pronounce on any of these points, though, from what I have seen, I would say that clean weeding is not so great a success with coconuts as it has been with rubber." (Director of Agriculture of F.M.S. in 1911 Report.)

Provided all the leaves of the trees have got beyond their reach, cattle and buffaloes may with advantage be allowed to graze over the plantation.

The dead leaves, as they fall or are picked off, should be heaped up in rows, not too high, between the trees, and burnt off as opportunity offers. It is of some advantage to lay clods of earth over these heaps before burning, as the burnt earth so obtained may be applied to the trees at the time the circle round them is being dug up.

Manuring.—Except to stimulate a lagging plant, manure should not be applied to young trees, for a field should be allowed to demonstrate what the soil can do for them before attempting to force them. The trees may be strong, but late of coming into flower, and when they do bear, the crop may be disappointing, or it may be in excess of the tree's strength, and a large percentage may drop at different stages

of growth. The first case calls for phosphates, and the second for nitrates.

The best manures for coconut trees are cow dung and salt mixed; fish refuse; bone dust; guano; castor cake; poonac.

Cattle manure is undoubtedly excellent, as it adds humus to the soil, and, much in the same way as lime, it binds a loose soil, and renders friable a hard clayey soil.

A very successful manure mixture used in Ceylon is in the following proportions—

200 lbs. rape cake.
150 lbs. fish manure.
200 lbs. bone phosphate.
50 lbs. sulphate of potash.
300 lbs. kainit (contains 30 per cent. salt).

This applied at 10 lbs. per tree costs, including transport and labour, about 8*d.* per tree.

Many planters favour semi-circular manure trenches at a few feet from the stem, but in the digging, the primary roots or lateral feeders are severed to the depth of the trench, and the tree to that extent is cut off from its accustomed feeding ground, and must depend on the artificial application.

The roots of the coconut tree are more vigorous toward the extremity of the primaries, and diminish gradually in strength toward the stem; therefore, manure placed in ploughed furrows between two lines of trees, or equidistant 15 feet from the stems, finds its way

more rapidly to the tree by means of the natural feeders than in a trench of cut roots at 6 feet from the stem.

Another system of manuring, recommended by Mr. L. C. Brown, Government Coconut Plantation Inspector to the F.M.S. Government, is as follows :—

"A trench is dug halfway round the tree, about 9 inches in width, and, say, 1 foot in depth, close to the extremity of the roots. This trench may be left open for a short time, then the manure filled in, and the soil that has been excavated replaced. The following year the other half of the tree is treated in a similar manner."

No tropical plant responds more generously than the coconut to high cultivation at the proper stage, and for every dollar spent in manure, treble is received in output in the first returning crop.

Fencing.—To prevent buffaloes, cattle, wild deer, and hogs from harming the trees, a strong five-strand wire fence should be erected round the plantation.

The ordinary five-strand wire type of independent wires may be used, but is not recommended, as, although it is cheap to construct, it is expensive to maintain, requiring constant inspection and repair.

It is a common experience to see such fencing with one or more wires broken or hanging loose, and under such conditions it is, of course, quite useless.

BOAT BUILDING. [*To face page* 32.
(Note scar-rings or age marks on trees.)

Wire mesh fencing is excellent if it is heavily galvanized after manufacture, and not woven from wiped galvanized wire, which may quickly rust at the knots where water is liable to collect.

An excellent kind for the purpose is a welded wire fence. This is a wire mesh made from oval wire, which helps to throw off the rain, and, in addition, as the upright wires are welded to the longitudinal wires, there are no knots or loops to collect water. It is also galvanized after manufacture, and although this makes it slightly more expensive in first cost, it lengthens the life of the fence by four or five times, and maintenance becomes practically *nil.*

The fixing of the fence is quite as important as the fence itself, if not more so, and security depends on the posts. These should be of good hard timber, firmly fixed from 2 to 3 feet in the ground. Particular attention should be paid to corner posts, end posts, and straining posts, all of which should be sunk from 3 to 4 feet into the ground, with bases and wing pieces well bolted to them to prevent pulling out or twisting.

CHAPTER IV

PESTS

THE planter should make a study of insecticides. Caterpillars, beetles, moths, weevils, borers, and other insects which attack the palm, either in the nursery or the field, can be kept well within control, and do comparatively little harm, by the ready and frequent use of kerosene emulsions and arsenical solutions, applied by means of a spraying machine, as required.

Beetles (Species of).—1. *Oryctes rhinoceros;* 2. *Rhynchophorus ferrugineus.* The two species of beetle which attack palms are quite different in appearance and habits and in their method of destruction, although they are usually found together, and must be treated of separately. One is *Oryctes rhinoceros,* commonly known as the rhinoceros, elephant, or black beetle. The other is *Rhynchophorus ferrugineus,* known as the red beetle; it is a large species of weevil.

Black Beetle (*Oryctes rhinoceros*). — This beetle belongs to the group of *Lamellicornia,* the larvæ of which live on decaying vegetable matter. In the case of this species, the parent

beetle deposits its eggs in the decaying stems of coconut trees, whether erect or fallen. The larvæ also occur in manure pits, cow dung, crushed sugar canes, and other vegetable remains.

The best preventive, therefore, for this pest is to hunt up and destroy the grub in all places where there is an accummulation of decaying vegetable matter. The larvæ or grub is readily distinguishable, being of a fleshy-white colour, with a body of from $2\frac{1}{2}$ inches to 3 inches when fully grown.

The method of attack of the black beetle is as follows : It flies by night to a palm, and makes its way to the base of a leaf-stalk and burrows into the heart of the cabbage, making a large hole, from which projects a quantity of the fibre of the tree resembling tow. The appearance of this tuft is evidence that the beetle has been at work. It remains in the hole usually all the next day, and may be captured in the burrow. It nibbles in so deeply that, not rarely, it bites through the growing point in the cabbage or bud of the palm. More often the attack is repeated, till the rain getting into the burrows sets up decay, which rots the palm through. In either case, the tree speedily dies. A tree once attacked seems to be very popular with all beetles.

It is very easy to distinguish trees that have been attacked by this beetle by the peculiar ragged appearance of the leaves. The beetle, in burrowing into the bud, often bites right

through the folded leaf in the cabbage, so that when it is unfolded the top is found to be bitten symmetrically off, or each leaflet is perforated regularly. By these appearances it is easy to tell whether a tree has been attacked or not, and so to judge of the state of the plantation.

Method of Destruction.—The usual method of destruction of this insect in the trees is to employ men to examine the bases of the leaf-stalks of the palms frequently, and to search for the beetles. They are provided with a flexible iron or copper wire terminated by a barb, with which the beetle is speared in its burrow and drawn out. A tree once attacked should be frequently examined, as it is more liable to future attacks than those which have never been attacked. So long as the beetle is killed by spear, there is no real need to extract it; in fact, it is, to a certain extent, advantageous to leave its remains in the hole, as no beetles will again enter the hole while the dead one is there. In any case, it is advisable to plug the holes with bits of rag or tufts of fibre dipped in weak carbolic acid, as this will deter beetles. One coolie per 100 acres is usually sufficient for beetling.

Red Beetle, or Weevil (*Rhynchophorus ferrugineus*).—This is far more destructive than the black beetle. Like the latter, though, it is nocturnal in its habits, flying at night to deposit its eggs in the coconut tree. By means of its

long ovipostor it reaches the base of the leaf-stalk of the palm and pushes its eggs deeply into the body of the tree. The egg, on hatching, produces a white, footless grub. It burrows tunnels through the soft growing parts of the palm, and when full grown nibbles its way to the surface and eventually hatches out into the perfect insect, when it flies away to commence its life work of propagation.

The red beetle is not favoured with any means for boring holes in the stem, and takes advantage, therefore, in so far as old trees are concerned, of any artificial openings, cuts, or, in particular, the bore holes of the black species.

The methods adopted for exterminating the black beetle in the tree also apply to the red, and it is common to find both kinds in the same hole. It is very probable that the extermination of the black beetle will greatly reduce the number of the red ones by preventing their getting into the heart of the tree by means of the burrows of the black insect.

The red beetle grub does its fatal work hidden from view, as with white ants, and is only discovered when too late. The first sign of anything wrong is usually the withering and fall of the central shoot. As soon as the grub is discovered, spare not the tree; it should be cut down and every bit burnt so as to prevent any remaining grub from arriving at the perfect stage and thus carrying on the work of destruction.

Termites Gestroi, **or White Ants.**—A species of white ant which, if not discovered in time, is fatally destructive to a tree it has attacked.

The colonies of white ants were, of course, resident in the jungle before it was felled, and they often remain on in the plantation, making their home in the fallen *débris*, from whence they prospect for living roots.

In the tender years they appear to leave plants untouched, but as the trees grow older and the roots go deeper, they attract the attention of the white ant. This may occur after three or four years' growth, and, unfortunately, the work of destruction goes on, generally unsuspected and therefore unhindered, till the tree is hollowed out and falls to the ground.

It would seem that precautionary measures are out of the question; the only thing to be done on discovery of a run is to pump in sulphur fumes by means of a patent fumigator, which is in general use in Malaya, and has been found to be highly successful.

A coconut plantation is not a popular hunting ground for the white ant, nor are the trees so agreeable to it as are rubber trees or other soft woods; further, the sandy soil is not habitual to the white ant. Probably these reasons account for the low percentage of loss on coconut estates from this pest.

A Coconut Pest

By L. C. Brown, Inspector of Coconuts

"Fortunately the coconut trees grown in the Straits and Federated Malay States do not appear to suffer from the disastrous effects of certain pests to the same extent as in many other countries. Take, for instance, the 'leaf disease'; it is always amongst us but does little or no harm to the trees, and again the 'bleeding disease' and 'dry rot' are practically unknown here. Whether this is due to more favourable climatic conditions or better cultivation it is difficult to say; at the same time it is undoubtedly the case that by a thorough attention to the culture of the palm, a great deal can be done to resist the pests and minimize the harm being done by them. The 'leaf disease' admittedly confirms this view, and from my own experience, I have no hesitation in saying that so far as 'beetles' are concerned, these insects seldom if ever attack or penetrate into the cabbage of a strong, healthy and well-developed tree; in other words, a tree that has been carefully cultured has the power of resisting most pests.

"Notwithstanding the fact that the coconuts grown in the Straits and Federated Malay States are apparently more immune from some pests than is the case in other countries, it is still disquieting to learn that now another pest

of a serious kind is attacking the coconut palms in the Philippines, and the Governor of the Straits Settlements has in consequence taken precautionary measures to prevent its influx here by prohibiting the introduction from the Philippines of any palms, alive or dead, or any stems of, or parts of stems or roots of palms.

"The insect that does the damage is related to the so-called white fly, which ravages the citrus groves of Florida, and as far as I am aware the pest has never made its appearance either in the Straits, Province Wellesley or the Federated Malay States.

"Mr. D. B. Mackie, Agricultural Inspector, in an article that appears in the *Philippine Agricultural Review* for March, 1912, informs us that the insect has been described by Mr. Quaintance of the Bureau of Entomology, United States Department of Agriculture, Washington, D.C., as *Aleyrodicus destructor*, and states that the insect may prove to be the most serious pest of the coconut palm in the Philippine Islands, but fortunately it is at present confined to a district in Negros Oriental, and is only attacking the young palms, *i.e.* from six to eight years of age. He states that eggs, which are very minute, are laid on the under surface of the leaflets, usually on the young leaves, and soon after the eggs are hatched the young insect begins walking about on the underside of the leaf and having located itself,

it inserts its beak through the epidermis of the leaf and begins to suck the sap from the soft inside tissue ; after becoming thus attached, the young insect seldom moves, unless disturbed, until it attains its full size. Shortly before emerging as a winged insect it stops feeding, but remains attached to the leaf. Though comparatively weak fliers, the danger of their passing through the air from one tree to another is greatly increased by the action of the wind, since, when the insect may only wish to fly from one leaf to another, it may be accidentally borne by the wind to a considerable distance.

"The pest does not apparently kill the tree, but very seriously affects the crop and the growth, and as regards the remedy, it appears that if the insects have already infested the trees all the leaves so attacked should be cut off and burnt, and spraying with kerosine oil may in some instances be advisable.

"It is, however, very satisfactory to learn that if the pest is taken properly in hand on its first appearance there is little chance of its spreading, and if this is the case I may impress again upon those interested in coconuts the importance of seeing that their plantations are thoroughly cultivated and maintained in good order."

Agricultural Pests Enactment.—To prevent the spread of pests it is interesting to learn that the Federated Malay States Government

has prepared a draft enactment to provide for the protection of trees, plants, and cultivated products from disease and pests. The objects and reasons are as follow: This draft aims at providing statutory means for combating the introduction and spread of pests injurious to cultivation. It is thought that these matters do not receive from all cultivators the attention necessary to protect so far as possible the crops of themselves and their neighbours from preventible disease, and that in the interests of cultivators it is desirable that power be created to make inspections, and to take or cause to be taken such measures as may, in the opinion of persons competent to judge, be expedient for securing the health of cultivated products and for recording and immediately dealing with outbreaks of disease. In this draft are included, as a matter of convenience, provisions *corresponding to those of the Coconut Trees Preservation Enactments*, 1898, which it is proposed to repeal (August, 1913).

Disease.—There are other dangers to which the palm is liable, such as root disease, leaf disease, bud rot, but these would appear to be more prevalent in the West Indies than in Malaya. A watchful planter, however, ought soon to detect disease and have it diagnosed by a mycologist. There are a number of helpful publications which should form part of a plantation library.

Amongst these are the following :—

Ferguson's well-known Ceylon handbook; Messrs. Hamel Smith and Pape's book on the Industry in general, containing a well-compiled chapter on Disease; Bulletin 228 of U.S. Department of Agriculture; and numerous publications from Government Agricultural Departments, most of which can be consulted or their source of publication traced through the excellent library at the Royal Colonial Institute, London.

CHAPTER V

MANAGEMENT OF THE CROP

Age of the Coconut Tree.—The tree arrives at full maturity at twenty-five years and endures for about one hundred years, and from the sixth year it should bear fruit all its lifetime. The age of a tree is decided by the number of scar rings which appear on the stem at the rate of two per annum.

Crops.—The yield of nuts depends much on soil, climate, and cultivation, and as may be imagined, crops vary in different parts of the world; given a good climate and an evenly distributed rainfall, a fair average soil and judicious cultivation, the return ought to be at least fifty nuts per tree per annum from three pickings, or about 2500 per acre.

Propping Bunches.—It is necessary where certain young trees have long fruit stalks which are not strong enough to support the nuts, to prop the bunches up by means of a strong willowy prop, forked at the end which supports the bunch, and pointed at the other for insertion into the trunk of the tree. Care should be taken in the length of the props used, for the bunches

only require to be raised to a slight extent. As the tree grows older it passes out of the propping stage.

Gathering.—Nuts fall when ripe, and usually during the night, which is said to account for so few accidents to people on the plantation. It is estimated that nuts which are allowed to ripen produce 10 per cent. more copra than when picked before they are fully ripe.

Climbing the trees for the collection of the fruit is one of the best methods. When the plantation is in full bearing, one coolie can collect at least four hundred nuts a day.

Notches for the resting of the foot when climbing the tree to collect fruit should be cut with a slope downwards, so that they do not retain the rain. It is of course understood that such notches can only be made on fully mature trees.*

The practice of using a knife attached to a long pole for cutting down the nuts is not to be recommended; in the bunches so collected several insufficiently ripe nuts will be found. At the time of collecting the nuts, all the dead spathes and leaves should be removed, and thorough search made to see that no beetles are in the trees. The coir substance which clings to the tree, and on which the leaves and spathes form themselves, should always be left, as it protects the cabbage and retains moisture.

* See West India Notes, p. 116.

It occasionally happens that a tree, although it has to all appearances matured, gives no sign of fruit or blossom. In such circumstances, a heap of leaves and rubbish burnt close to the trunk of the tree, has the desired effect of bringing the tree into bearing, but this should only be done when absolutely necessary.

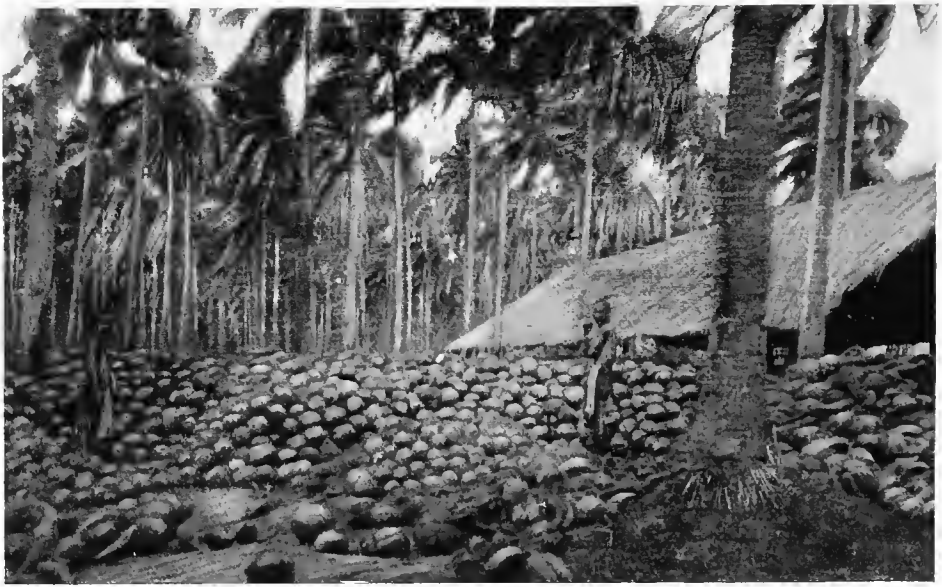
Husking.—The process of husking is very laborious, yet simple. The husk is torn off after it is split by striking the nut smartly on the point of a steel crowbar, or sharpened hard-wood stake, firmly fixed in the ground with the pointed end up.

Oil Machinery.—The usual system adopted is to crush out the oil from the copra by hydraulic machinery; the copra is first ground into a mass like saw-dust; this is subjected to steam and then pressed by machinery, the oil running out, and the refuse forming a cake called *poonac*, which is very valuable as cattle food or manure.*

Poonac.—After the oil has been pressed out of the copra the residue is called poonac, or coconut meal. The value of this by-product is rapidly increasing, not only on account of its beneficial uses as cattle feed, but as an organic fertilizer of high grade. The crushed copra gives off about 62 per cent. of oil, leaving the balance, 38 per cent., as poonac.

* See chapter on machinery on pages 63 to 81.

PLATE V.



HUSKING NUTS. [*To face page* 46.

The material is readily saleable at good profit, but on large estates, where the copra is turned into oil, it pays best to keep the poonac for the feeding of cattle, pigs, and poultry, which in turn, apart from their uses for human purposes, do immense good to a plantation by their droppings.

Extraction of Toddy or Sugar from the Tree.—The spathe or blossom of the tree may also be used for extracting the juice from which is prepared toddy or sugar, by a process very easily acquired from the natives, and some are of opinion that it brings on the young trees more quickly than would otherwise be the case.

This treatment should not be continued too long—say one year, after which the nuts should be allowed to mature and be collected in the usual way.

A considerable period should then be allowed to elapse before again treating or tapping the young shoot of the tree for this purpose.

CHAPTER VI

COPRA AND COIR

Copra.—This is simply the kernel broken into pieces—usually quarters—and dried in the sun, or by means of artificial heating. Only ripe nuts can be used for making this product, and they are kept unbroken for about three weeks after gathering, as the copra dries more quickly and gives a larger proportion of oil and, moreover, does not turn mouldy. Copra contains about 62 per cent. its weight in oil.

Copra is usually shipped to the European market in the dried quarter-kernel form, but for confectionery purposes the nut is disintegrated, and the product takes the form of prepared dust. The process is somewhat as follows—

The red rind is shaved off the nut, leaving the bare white kernel, which, after thorough washing, is passed on to the disintegrating machine and ground to a mass, which has the appearance of having been grated. In this condition it is dried at a temperature of about 150° F.; after cooling it is graded by sifters into three grades, fine, medium, coarse. The produce is then packed in tin-lined cases, containing approximately a Straits picul, or 133$\frac{1}{3}$ lbs., and is then ready for the foreign market.

Mr. L. C. Brown, Government Inspector of Coconut Plantations in the F.M. States, suggests a cheap drying kiln for copra, as follows :—

"For the manufacture of copra unripe nuts are useless, and great care should be taken to pick only fully ripe ones. One coolie ought to husk five hundred nuts a day. A better return is obtained if the nuts are stored for a month or so before being opened, and it lessens the cost of manufacture as the kernel is more easily extracted from the shell.

"The nuts, after being split open, should not be laid on ground which is moist and muddy, as in this way grit and dirt get into the kernel, and this tends to lower the quality of the copra.

"While the collections are comparatively small, a very cheap drying kiln for the treatment of copra may be constructed in the following manner—

"A table, 12 feet square and 4 feet in height, with a platform made of nebongs, must first be erected.

"This table is then covered round with a mud wall, $1\frac{1}{2}$ feet in width and 6 feet high, leaving a small open space in this shape ⌂ on one side to allow of the fuel, which is generally the coconut shell, being placed beneath the platform. For sun-drying purposes, in connection with the kiln, a drying table is required, say, 50 feet long by 6 feet from the ground.

"The woodwork for the above structures may be entirely made from the nebong palm, which

is very abundant in the forest lands throughout the States, and consequently not costly."

Sun-dried copra is generally admitted to be the best, and if kept free from mould, has a larger percentage of oil than mechanically dried copra.

In Malaya four or five days is allowed for the sun-drying method; half a day if over grill or nebongs, and from two to three hours if by hot-air process.

The Chinese copra maker of Malaya, although fairly familiar with the many uses to which coconut oil can be put, has not yet accustomed himself to the idea that manufacturers now require it for butter, edible oil, confectionery, and other forms of human food, and it will be to his advantage to adjust his methods of curing to suit modern requirements. The old-fashioned fire-drying processes must give way to methods that do not allow the copra to be scorched or permeated with smoke from the husk fires, thus often rendering it unfit for human food purposes. Also, it must not run the risk of being partially dried, and so become mouldy, for in this state decay soon sets in.

To be successful, therefore, and keep in line with other sources of supply, the system of smokeless drying must be adopted. Old-established customs die hard, but if native plantation owners were fully cognizant of the harm their crude primitive methods have done to Malayan rubber, they would not, on the eve of greater

PLATE VI.

SHELLING COPRA. [*To face page* 50.

developments in the coconut industry, turn a deaf ear to ideas, that not only make for a pure and more saleable article, but for enhanced profits to the growers.

Extract from Report of the Director of Agriculture to the Federated Malay States, 1911 :—

"**Coconuts.**—The Inspector of Coconuts estimates the total area under coconuts in the Federated Malay States at, approximately, 142,774 acres, an increase of 12,430 acres, or about 9½ per cent. over the total for 1910. The area in several States is as follows—

Perak	...	...	...	73,120 acres.
Selangor	...	...	...	33,355 ,,
Negri Sembilan	...	...	...	19,584 ,,
Pahang	...	...	...	16,715 ,,

"It is gratifying again to record a steady increase in the area under this valuable and reliable crop. From the area now under cultivation the Inspector of Coconuts estimates, taking an average of forty nuts per tree, that there will be produced 1,100,000 piculs (65,500 tons) of copra, provided that the whole of the nuts were converted into this product. The by-products also should eventually be used on a much larger scale for the manufacture of coir matting, rope, etc."

"**Coir.**—The fibre from the husk is called coir, and in tropical countries is used very extensively

for mattresses ; its principal uses, however, are for mats, ropes, yarn, cordage, brooms, brushes, etc. The husk, or pericarp, of forty nuts yields about 8 lbs. of coir, but in some of the Malayan plantations, where the nuts are very large, this is exceeded. A rough and ready estimate puts the yield of coir at 10 *lbs. per tree.*

The husks are soaked for some weeks in pits filled with water, in order to loosen the fibre; the hand process for obtaining the latter is by beating with heavy clubs, but machinery is much more expeditious and cleanly. The husks are straightened in a crushing mill; machinery in the form of a wheel set with many small teeth teazes out the fibre and at the same time cleans it. The fibre is then sorted into grades according to its fineness or coarseness.

The market knows two kinds of fibre : " Bristles " and " Mattress." The former is sold at about £25 per ton, and the latter at £15. There is, however, a third class known as refuse fibre, which fetches about one-third of the price obtained for first quality. An estate of about 1500 acres should, in addition to an oil mill, have its own fibre factory.

CHAPTER VII

ESTIMATES

To bring into bearing an estate of 500 acres. Planting distance, 30 feet × 30 feet = 48 trees per acre.

1st year	Exchange 2*s.* 4*d.*	£	*s.*	*d.*
Land and buildings—				
Land premium to Government, 500 acres at $3	$1,500 =	175	0	0
Survey fees	500 =	58	6	8
Quit rent	500 =	58	6	8
Manager's bungalow and furniture	2,500 =	291	13	4
Coolie lines	1,000 =	116	13	4
Tools	300 =	35	0	0
	$6,300 =	£735	0	0
Development, etc.—				
Felling, 500 acres at $7	$3,500 =	408	6	8
Burning, ,, ,, 1	500 =	58	6	8
Collecting and stacking trees up to 5" in diameter, 500 acres at $6...	3,000 =	350	0	0
Lining and measuring 500 acres at $1.50	750 =	87	10	0
Holing, 500 acres at $3	1,500 =	175	0	0
Planting and filling in, 500 acres at $1.50	750 =	87	10	0
Nurseries, 500 acres at 0.50 ...	250 =	29	3	4
Selected seed, 40,000 at 8 cents	3,200 =	373	6	8
Roads and drains, at $3 per acre	1,500 =	175	0	0
Fencing, at $3 per acre	1,500 =	175	0	0
Medical requirements	500 =	58	6	8
Superintendence, 1 European at $300 per month	3,600 =	420	0	0
Carried forward	26,850 =	3132	10	0

		£	s.	d.
Brought forward	$26,850 =	3132	10	0
Servant allowance—				
1 cook, at $15 per month ...	180 =	21	0	0
1 house servant, at $12 per month	144 =	16	16	0
1 postman, at $25 per month	300 =	35	0	0
Monthly weeding for 10 months of year at $1.50 per acre per month	7,500 =	875	0	0
Contingencies	1,000 =	116	13	4
Transport	300 =	35	0	0
	36,274 =	4,231	19	4
Add 6 per cent. interest ...	2,436 =	284	4	0
	$38,710	£4,516	3	4

2nd year.

		£
The cost of up-keep, development and all-in charges should not exceed (including 6 per cent. interest, $780)	$13,000 =	1,450

3rd year.

All-in cost (weeding put at 80 cents) (including 6 per cent. interest, $780) ...	13,000 =	1,450

4th year.

All-in cost (weeding put at 50 cents) (including 6 per cent interest, $600) ...	10,000 =	1,170

5th year.

All-in cost (weeding put at 40 cents) (including 6 per cent. interest, $570) ...	9,500 =	1,100

6th year.*

All-in cost (weeding put at 30 cents) (including 6 per cent. interest, $480) ...	8,000 =	930

---

* This is the producing year, and there must be added cost of collecting produce—a charge against revenue, namely—

		£
Picking—10 nuts per tree = 240,000 nuts ...	$240	
Curing ,, ,, ,, say ½ cent	1,200	
Transport ,, ,, ,, ...	1,200	
	$2,640 =	310

7th year.		£
All-in cos same as 6th year	$8,000 =	930
Plus, *revenue account*—		
Picking, 30 nuts per tree = 720,000 ...	720	
Curing ,, ,, ,, at ½ cent	3,600	
Transport ,, ,, ,, ...	3,600	
	$7,920 =	£924

8th year. 9th year.
All-in cost of up-keep—approximately ... £1,000 p.a.

Note.—Cost of collecting, curing, and transport of nuts may be estimated at 1¼ cents per nut.

Summary

Estimate for bringing into bearing 500 acres coconuts, adding 6 per cent. per annum on capital invested.

	Total cost. £	s.	d.	Per acre. £	s.	d.
1st year	4,516	0	0	9	0	0
2nd ,, ...	1,450	0	0	2	18	0
3rd ,, ...	1,450	0	0	2	18	0
4th ,, ...	1,170	0	0	2	7	0
5th ,, ...	1,100	0	0	2	4	0
6th ,, ...	930	0	0	1	17	0
	£10,616	0	0	£21	4	0

Notes on Estimates

Land Charges.—These have been taken as the highest ruling in Malaya.

In Johore and Eastern States of the Malay Peninsula, land rates are cheaper and soil equally good.

Buildings.—Care should be taken not to expend too much on buildings until health and

water conditions are established and a central site for factory decided on; the same remark applies to roads.

Seed Nuts.—Almost double the number required has been allowed for, though 80 per cent. should germinate—seedlings over are readily saleable.

Fencing.—If the estate felling is given out on contract, the contractor should cut and supply free uprights for fencing from hard wood—the estate to provide the wire.

Weeding.—This should be done by hand, and where hoeing or changkolling is done to eradicate lalang grass, Chinese labour is best, as the Chinaman puts more back into his work than the Javanese or Tamil coolie.

The cost of weeding and keeping an estate thoroughly clean should be approximately as follows:—

1st year	$ 1.50	per acre.
2nd ,,	1.00	,,
3rd ,,	80 cents	,,
4th ,,	50 ,,	,,
5th ,,	40 ,,	,,
6th ,,	30 ,,	,,

As the trees grow older the shade from the palm's large branches is a great check to weed growth, and in this respect at the producing stage a plantation can almost be left to itself. Once the mastery is gained in the early years

the weeding cost tapers down to a little over 6*d.* per acre.

Roads and Drains.—If this is light re-shaping work, it should be done by the weeders and be included in their price per acre. A contract should always set this out, otherwise the planter will find that extra pay will be required for anything outside the actual weeding.

Payments to Contractors.—It is always as well to aim at keeping in hand a margin of completed work in favour of the estate. Have regular pay-days and pay the contractor 80 per cent. of completed and measured work. The coolies get to know regular pay-days and in turn when to expect their money from the contractor.

It is an asset to an estate to get a good name with labour for just and prompt payments. Frequent and ready loans, either to contractors or coolies, are not appreciated as one would think, but are looked upon as a sign of weakness and inexperience.

Profit from Coir and By-Products

With 1500 acres or over in full bearing, the crops will be sufficient to feed an oil mill, and in connection therewith a coir factory might be erected for the manufacture of fibre into rope.

An estimated profit from this by-product is put as follows:—

2½	million	nuts	gives a net	profit of	£1,000
5	,,	,,	,,	,,	3,500
10	,,	,,	,,	,,	10,000.

Equivalents in Oil (Approximate)

A fair average figure for calculating outputs is 5000 nuts per ton of copra. (Trees 30 feet × 30 feet = 48 trees per acre.)

Therefore—

1 ton copra = 62 per cent. oil, 38 per cent. poonac.
62 per cent. oil (or 1,390 lbs.) = 150 gallons (1 gallon = 9¼ lbs.)
1 mature tree = 1½ gallons oil per annum, and 10 lbs. coir.
1 ,, acre = 70 ,, ,, and 4¼ cwt. coir.
3½ ,, acres = 240 ,, ,, and ¾ ton coir.
240 gallons oil = 1 ton oil.
500 nuts = 133⅓ lbs. oil = 1 picul oil.

In the West Indies 6000 to 7000 nuts, according to cultivation, is the estimated equivalent of one ton copra.

Coconuts: Annual Net Profits Per Acre from Copra only.

Given plantings approximating 50 trees per acre. Good cultivation, reasonable transport facilities, and the all-in cost of copra not above £9 per ton.
(If estate above 1000 acres add fibre profits shown elsewhere.)

Grose selling price of copra.	Average nuts per tree per annum.																					
	10			20			30			40			50			60			80			100		
£	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
16 per ton	0	14	0	1	8	0	2	2	0	2	16	0	3	10	0	4	4	0	5	12	0	7	0	0
17 ,,	0	16	0	1	12	0	2	8	0	3	4	0	4	0	0	4	16	0	6	8	0	8	0	0
18 ,,	0	18	0	1	16	0	2	14	0	3	12	0	4	10	0	5	8	0	7	4	0	9	0	0
19 ,,	1	0	0	2	0	0	3	0	0	4	0	0	5	0	0	6	0	0	8	0	0	10	0	0
20 ,,	1	2	0	2	4	0	3	6	0	4	8	0	5	10	0	6	12	0	8	16	0	11	0	0
21 ,,	1	4	0	2	8	0	3	12	0	4	16	0	6	0	0	7	4	0	9	12	0	12	0	0
22 ,,	1	6	0	2	12	0	3	18	0	5	4	0	6	10	0	7	16	0	10	8	0	13	0	0
23 ,,	1	8	0	2	16	0	4	4	0	5	12	0	7	0	0	8	8	0	11	4	0	14	0	0
24 ,,	1	10	0	3	0	0	4	10	0	6	0	0	7	10	0	9	0	0	12	0	0	15	0	0
25 ,,	1	12	0	3	4	0	4	16	0	6	8	0	8	0	0	9	12	0	12	16	0	16	0	0
26 ,,	1	14	0	3	8	0	5	2	0	6	16	0	8	10	0	10	4	0	13	12	0	17	0	0
27 ,,	1	16	0	3	12	0	5	8	0	7	4	0	9	0	0	10	16	0	14	8	0	18	0	0
28 ,,	1	18	0	3	16	0	5	14	0	7	12	0	9	10	0	11	8	0	15	4	0	19	0	0
29 ,,	2	0	0	4	0	0	6	0	0	8	0	0	10	0	0	12	0	0	16	0	0	20	0	0
30 ,,	2	2	0	4	4	0	6	6	0	8	8	0	10	10	0	12	12	0	16	16	0	21	0	0
31 ,,	2	4	0	4	8	0	6	12	0	8	16	0	11	0	0	13	4	0	17	12	0	22	0	0
32 ,,	2	6	0	4	12	0	6	18	0	9	4	0	11	10	0	13	16	0	18	8	0	23	0	0
33 ,,	2	8	0	4	16	0	7	4	0	9	12	0	12	0	0	14	8	0	19	4	0	24	0	0
34 ,,	2	10	0	5	0	0	7	10	0	10	0	0	12	10	0	15	0	0	20	0	0	25	0	0
35 ,,	2	12	0	5	4	0	7	16	0	10	8	0	13	0	0	15	12	0	20	16	0	26	0	0
36 ,,	2	14	0	5	8	0	8	2	0	10	16	0	13	10	0	16	4	0	21	12	0	27	0	0

Note.—The Government Inspector estimates 3696 nuts = 1 ton; the above table is based on 5000 to 1 ton copra.

Mature Estates

A search for a reasonable buying figure per acre. It would not be unreasonable for an investor in tropical agriculture to expect a return of 20 per cent. per annum or a five years' purchase on his capital. Forty nuts per tree per annum is a conservative average crop for a well cultivated estate. The Government Inspector estimates 3696 nuts = 1 ton copra. These estimates are based on 5000 nuts to 1 ton copra.

Example.—When the gross selling price of copra is £25 per ton, the net profit per acre is £6 8*s.* 0*d.* Multiply this by five years' purchase, and the buying price per acre is £32. On this basis the following table is arranged :—

When the gross selling price of copra is	* The purchasing price per acre on 5 years' net profit is
£20 per ton	£22 per acre.
21 ,, ...	24 ,,
22 ,, ...	26 ,,
23 ,, ...	28 ,,
24 ,, ...	30 ,,
25 ,, ...	32 ,,
26 ,, ...	34 ,,
27 ,, ...	36 ,,
28 ,, ...	38 ,,
29 ,, ...	40 ,,
30 ,, ...	42 ,,

(See table on page 59.)

* Note.—Some valuers claim that the number of years' purchase should be seven.

Immature Estates

In buying an estate not yet arrived at the producing stage the following may be a guide (given always fair average conditions).

Take present-day gross selling price of copra per ton—for the purpose of this explanation it is taken at £25 per ton.

Therefore—

	£	s.	d.
1st producing year at 10 nuts, the profit per acre (as per table on page 59) is	1	12	0
2nd ditto, at 20 nuts, ditto	3	4	0
3rd ditto „ 30 „ ditto	4	16	0
4th ditto „ 40 „ ditto	6	8	0
5th ditto „ 50 „ ditto	8	0	0
	£24	0	0

Therefore on the basis of five years' profits, £24 per acre (copra at £25 per ton) is the purchasing price per acre for an estate just commencing to bear.

In the case of deferred revenue, deduct about £2 10*s.* 0*d.* per acre for each year without revenue.

In these estimates good-will is not taken into account.

* * * *

TABLE—Showing net profit per cent. on capital invested, given good cultivation and no abnormal conditions. Estimates based on mature estate—fifty trees to acre, average yield fifty nuts per tree.

Example.—When copra is selling at £28 per ton gross, an estate which has cost £30 per acre will give a return of 32 per cent. on capital invested.

Market price of copra per ton—Gross ...	£22	24	26	28	30	32	34	36
Net profit per acre ... (See table, page 59)	£6½	7½	8½	9½	10½	11½	12½	13½
All-in cost of estate per acre	Net percentage on capital invested.							
£15	43	50	57	63	70	77	83	90
20	32	37	42	47	52	57	62	67
25	26	30	34	38	42	46	50	54
30	22	25	28	32	35	38	42	45
35	18	21	24	27	30	33	36	39
40	16	19	21	24	26	29	31	34
45	14	16	19	21	23	26	28	30
50	13	15	17	19	21	23	25	27
55	12	14	15	17	19	21	23	25
60	11	12	14	15	17	19	21	22

NOTE.—Fractions are omitted for convenience.

CHAPTER VIII

MACHINERY AND PLANT FOR COCONUT FACTORIES

A FACTORY for the treatment of the coconut may contain plant for the production of copra, coconut oil, oil cake, manure, fibre fibre products, together with packing, plant, and machinery, for making barrels, tins, etc.

The series of buildings might be:

(1) Power house.
(2) Nut store and splitting house.
(3) Copra drying house.
(4) Oil mill.
(5) Oil store and packing plant.
(6) Fibre mill.
(7) Tin and barrel-making plant.

These buildings might be further subdivided or associated, for economy in power transmission, and transport of materials.

Splitting the Nut.—The simplest method of splitting the nut consists in striking it upon a vertical steel spike fixed on a post, but in up-to-date mills the nuts are fed by hand or conveyor into a splitting machine consisting of three disc knives with reversed ratchet teeth

rotating at an angle of 120 degrees to each other. The machine divides the complete nut into three equal segments at the rate of from 80 to 100 per minute. Arrangements are sometimes made below the machine for the collection of the milk while the solid portion is carried away by a short band conveyor. Boys at the side of the conveyor transfer the husks and shells to trucks, while the meat is carried forward to the drying house.

Copra Drying House.—The crude methods adopted by natives for the production of copra, viz., sun-drying, smoke-drying, etc., are unsuitable for commercial work and some form of hot-air drying plant is essential. Practically 50 per cent. (the error being about 3 per cent. on either side of 50) of the weight of the green copra is extracted as moisture on drying, and the dried copra will still contain from 8 to 10 per cent. of moisture. This amount of water may be removed in from two to twelve hours according to the process and the character of the plant. The quality of the copra is naturally modified by the character of the drying process, too slow or too rapid drying producing characteristic defects. A drying process using hot air and taking about four hours appears to give the best results. The association with the hot air of anti-putrefactive agents such as sulphur dioxide, to prevent fermentation and decomposition, contributes to improved quality.

PLATE VII.

CRUSHING COPRA FOR OIL EXTRACTION. NATIVE MORTAR AND PESTLE WORKED BY BULLS (THE CHEKKU).

[*To face page* 64.

The drying house (Fig. 1) which is used in other tropical industries is often used for copra. The floor A consists of thin perforated galvanized iron sheets. The furnaces are fed with shell, fibre, wood or other fuel, and the heat given off by the flues C raises the temperature of the air to about 70° C. The floor is charged and discharged at intervals depending on the weather,

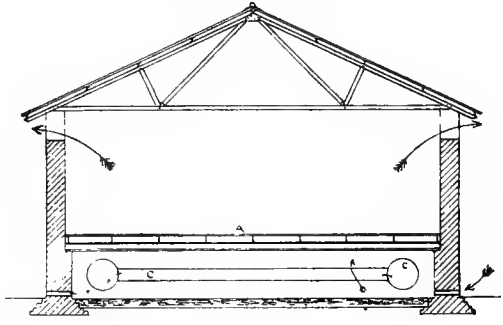


Fig. 1.

the design of the plant, and its management; usually twice a day. In more recent designs steam piping is used in place of the flues, and fans are used to circulate the air.

Rotating drying cylinders and drying conveyors are also used. The tunnel dryer (Fig. 2) is a great favourite in some districts. The green copra is charged on to light pallets or frames A, which are stacked on trucks B. A current of

hot air is blown in through the channel C, and a smaller current of ordinary air through channel D.

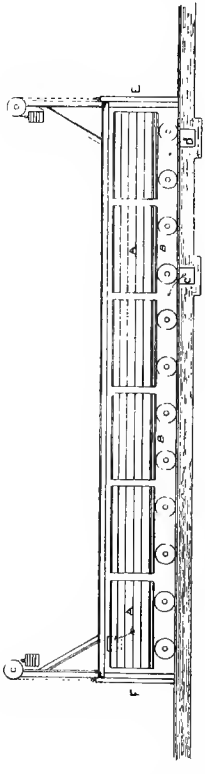


Fig. 2.

The trucks enter the tunnel at E and leave the tunnel at F at suitable intervals. The trucks are carried forward by an endless chain or other means. The cool air from D saves heat in drying, by withdrawing that from the dried material.

The curves (Fig. 3) will enable one to handle drying questions involved in these plants. The volume in cubic metres per kilo. of dry air, and the amount of moisture associated at different temperatures and degrees of saturation with every kilo. of dry air, is shown by the curves and will enable the practical man to increase his output or improve his economy in a given case. The full discussion of such problems is, however, beyond the scope of this book.

The Oil Mill.—The composition of copra

varies with the ripeness of the nuts and the

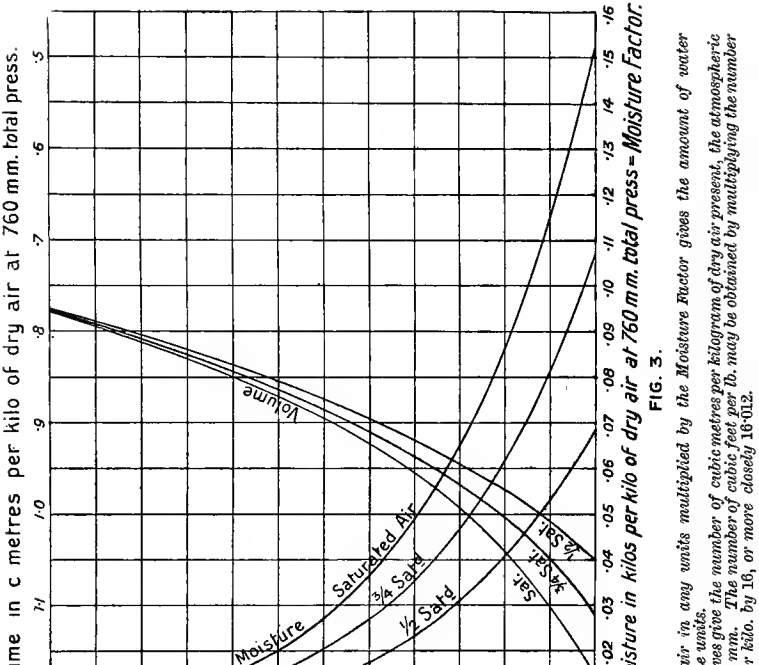


FIG. 3.

The weight of air in any units multiplied by the Moisture Factor gives the amount of water present in the same units.
The Volume curves give the number of cubic metres per kilogram of dry air present, the atmospheric pressure being 760 mm. The number of cubic feet per lb. may be obtained by multiplying the number of cubic metres per kilo. by 16, or more closely 16·012.

methods of drying. The amount of oil present

usually exceeds 60 per cent. of the weight of the copra, and may be extracted either by pressure or by solvents, or by a combination of the two processes. The frontispiece to this article represents a native oil-pressing plant, the pressure being applied to the copra meal by means of a lever attached to a wooden pestle in a wooden mortar. In commercial factories the pressure method is generally adopted, the residue or poonac from the treatment, containing 8 or 10 per cent. of oil, being obtained in the form of cakes suitable for cattle feeding. When such oil cakes are not in demand, the solvent process may be used, when the amount of oil retained in the residues is negligible; such residues are used as manure or as fuel.

On account of the high percentage of oil in copra, two pressings are usually adopted, but with the latest types of presses, and especially where rich residues may have some advantages, or where such residues are treated with solvents, one pressing process may be sufficient.

The copra as received from the drying house, after being passed through a magnetic separator for the removal of nails, etc., which may accidentally have become associated with it, is broken down either by means of disintegrators, fluted roll mills, or edge-runner mills. The disintegrated copra is then charged into a steam-heated kettle, by which the material is uniformly heated to about 35° to 45° C. before being pressed.

The copra meal to be pressed is charged, in

quantity sufficient to form a cake, between plates arranged in series to receive pressure

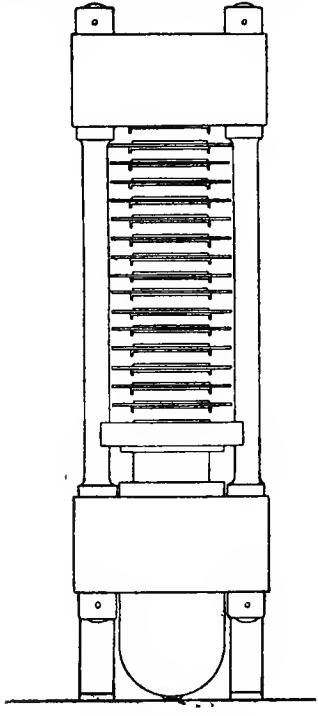


FIG. 4.

from the ram of a hydraulic press. While the material is being submitted to pressure some

means must be provided to prevent its lateral escape from the press plates.

Modern presses are of two leading types; 1st, plate presses (Fig. 4), in which the pressing plates are not removed and the meal to be pressed is previously moulded and squeezed to small bulk in moulding machines; 2nd, cage presses (Fig. 5), in which a perforated cylinder or cage is used to contain the loose plates and meal, no cake-forming machine being required. Such cage presses are usually adopted for first-pressing operations, especially when pressing cold, and are now made to work regularly at a pressure of three tons per square inch.

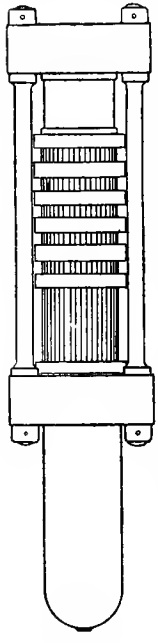


FIG. 5.

The cage is constructed with vertical steel bars held to form a cylinder by means of external steel rings. As a rule one charging kettle is erected over each pair of presses, but where considerable time for the pressing is required, when one pressing only is used, the cages are arranged to travel backwards and forwards between the kettle and the presses, when one kettle may serve any number of presses. Generally the time of charging and discharging

is about equal to the time of pressing, and one kettle serves two presses. Simple measuring boxes under the kettle, by being alternately opened and closed at the top and bottom, deliver sufficient meal for each cake. As charging takes place, the ram is lowered and steel or malleable iron plates are inserted between each layer of meal. These plates are usually galvanised to prevent the adhesion of the oil cake formed. Similar presses with solid cylinders are used when making oil cakes from mixtures of rich and poor residues, where no oil extraction takes place.

The second pressing is generally conducted in plate presses. The cakes from the cage presses are broken down in fluted roller mills, and the material ground to break up further the oil cells in the material. The meal is delivered into a steam-heated kettle, measured and moulded to form a compact cake in a cake-moulding machine. The cake, with its press cloth folded over the sides to prevent lateral flow, is slid between the plates of the plate press ready for pressing.

For this operation one kettle usually serves four plate presses, so that the time of pressing is four times that of charging and discharging. After removal from the press the cakes are trimmed in a cake-paring machine, by which about 25 per cent. of the weight is removed from their outer edges. The parings usually contain 14 to 16 per cent. of oil, and are returned for re-pressing. The expressed oil as

it flows from the presses is pumped into tanks for clarification. Such tanks have vertical partitions so that mucilage and other extraneous matter is retained by the partitions as it settles out, while the oil flows from the inlet to the outlet of the tank. The partially clarified oil is then further treated by passing through a filter press which removes all the associated solid and mucilaginous matter.

The removal of the finished oil from the stock tanks to tins or barrels for the market calls for no special comment. The Appendix gives particulars and prices of suitable plant for pressing two tons of copra per hour.

The Solvent Process of Oil Extraction.—In this process, which is not well adapted for tropical exploitation, the meal is charged into a large vessel, in which it is treated with a hot solvent for oil, such as petrol, benzene, carbon di-sulphide, etc. The solvent, in flowing through the mass, carries away its associated oil, from which it is separated by distillation. The condensed solvent is returned to the extracting vessel, and the oil remaining in the still is removed for clarification or for sale.

At the close of the operation, which in the case of a 10-ton plant may take from four to six hours, steam is driven through the mass to remove the retained solvent, and the residue discharged from the extracting vessel. Such residue forms a valuable manure.

Treatment of the Husk.—The separated husks are soaked in water for fourteen days at least, so that the fibres may loosen from each other and the associated cellular matter. One month's soaking is usually allowed, and a longer time helps the processes. Large tanks, 20 feet by 8 feet by about 6 feet deep, are constructed of ferro-concrete or cemented brickwork, for the purpose of soaking the husks, and provision must be made at the edges of the tanks, which may be, say, 30 inches above the ground, for securing planks to hold the husks under the water. The effect of the soaking will vary with the size of the husk and the temperature and quality of the water.

Fibre Mill.—The soaked husks are first passed through husk-crushing mills, consisting of a pair of coarse-fluted rolls, which bend and flatten the husk as a preliminary treatment for fibre separation. The husks are not allowed to dry at any stage, and after crushing are delivered to the workmen at the fibre extractors. A fibre-extracting machine (Fig. 6) consists of a rotating cylinder provided with teeth, which tear out the soft matter and separate the fibres in the husk. The machines are worked in pairs, one having coarse teeth for breaking down and the other fine teeth for finishing. The workman takes hold of a piece of husk and places it between the feed rolls of the machine, when the teeth of the revolving drum comb out the fibres; he then

opens the feed rolls and reverses the piece of husk, so that the portion previously held in the hand is combed out. He again withdraws the piece and passes it to the workman at the finishing machine, which removes all the fibre left, except the coarse fibre called "bristle fibre," which, after drying, is combed, cleaned, sorted into qualities, and bundled for sale.

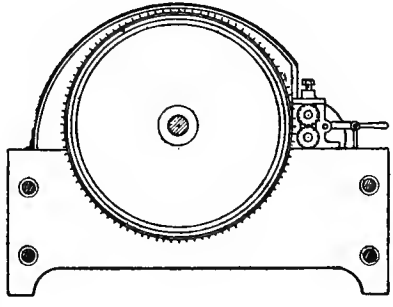


FIG. 6.

The separated fibre from the finishing extractor is cleaned from dirt, hard bits, and embedding matter by means of a willowing machine (Fig. 7), which consists of an inclined revolving screen, in which beaters are rapidly rotated to "beat" the material on to the screen, through which the dirt, etc., passes.

The cleaned fibre may then be dried and formed into bales by means of a bailing press for market.

For conversion into yarn for the manufacture of rope, mats, etc., the fibres must be straightened out by means of hackles, or partly by the aid of milling machines.

The straightened or hackled fibre is spun into yarn by means of a spinning machine, which twists the yarn and winds it on a bobbin, the

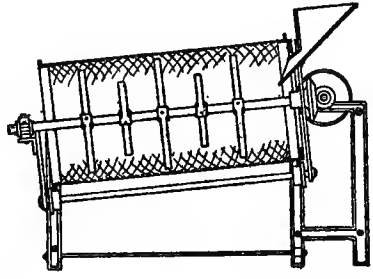


Fig. 7.

size of the yarn being regulated by the spinner, who delivers it evenly to the machine.

A cabling machine further twists two yarns together to form cabled yarn, and hanking and bundling machines pack the cabled yarn for market.

The coir yarn produced may be further treated for the manufacture of ropes, mats, etc.

Estimates of Cost of Production of Coconut Oil and Oil Cake in a Tropical Country

Basis of Estimates.—The factory is capable of treating fifty thousand nuts per day. The nuts weigh four hundred and thirty-five to the ton, *i.e.* the total weight is 115 tons (1 nut weighs 5 lbs. approx.).

From an examination of nuts in the Malay States the average composition may be taken as—

Husk	...	34 per cent.	
Milk	...	24 ,,	
Shell	...	12 ,,	
Meat	...	30 ,,	(yielding 14 per cent. of copra).

In the estimates which follow the nut is taken to yield—

Husk	...	30·0 per cent.
Meat	...	27·8 ,,
Dried Copra	...	10·85 ,,

Or, four thousand nuts yield 1 ton of dried copra. The husk is taken to yield—

Short Fibre	...	2·45 per cent.
Long Fibre	...	8·05 ,,
Mattress and Spinning Fibre	...	24 ,,

The dried copra is assumed to yield—

Coconut Oil	60·0 per cent.
Oil Cake	33·6 „
Loss, moisture, etc.	6·4 „

For nuts of other size and composition the estimates will need modification.

	Total cost. £	s.	d.		Cost per ton of oil produced. £	s.	d.
Transport of nuts to factory at 8*d.* per ton	3	16	8	...	0	10	2½
Splitting nuts (two machines) ...	0	6	0	...	0	0	9½
Charging drier. 32 tons (green copra)	0	10	8	...	0	1	5
Discharging drier. 12·5 tons (dry copra)	0	4	2	...	0	0	7
Fuel for drier (reduced if husks are consumed)	3	3	9	...	0	8	6
Sundries, renewals, etc.	0	3	0	...	0	0	5
	£8	4	3		£1	1	11
Oil extraction—							
Magnetting, crushing, disintegrating; 1st pressing, breaking down cakes, moulding; 2nd pressing, paring, etc., labour	1	8	0	...	0	3	9
Power	3	0	0	...	0	8	0
Sundries, press cloth, lubricating oil, etc.	0	11	3	...	0	1	6
	£13	3	6		£1	15	2

i.e. 50,000 nuts would yield 7·5 tons of oil; 4·2 tons of oil cake } value on London market, £300 to £350.

The value of oil on the London market is at present lower than in most tropical markets, but as more oil is produced in the tropics this condition may change.

To the above must be added—

(1) Cost of nuts; (2) Rent of land and interest on first cost of plant; (3) Depreciation on plant; (4) Superintendence.

The method of packing and cost will depend on the market, and should not exceed £2 10*s.* per ton.

Treatment of the Husks—

	£	*s.*	*d.*
Transport of husks (fifty thousand nuts) to soaking pits = 34·5 tons	1	0	0
Treatment at crushing machines (five machines)	0	15	0
Fibre extracting (sixty machines)	9	0	0
Willowing (five machines)	0	15	0
Packing into bales	0	4	0
Sorting, trimming and combing fibres	5	0	0
Sundries, oil, etc., repairs	6	5	0
Power	5	0	0
	£27	19	0
Add for contingencies	6	1	0
Total	£34	0	0

Yield (from 50,000 nuts)—

Short bristle fibre ...	0·84 tons	Value in London £140 to £160.
Long ,, ...	2·76 ,,	
Mattress and spinning fibre	8·4 ,,	

To the above costs must be added, as before, charges for—

(1) Interest on first cost of plant; (2) Depreciation; (3) Superintendence. Renewals and repairs are already included.

ESTIMATES RELATING TO PLANT AND BUILDINGS.

Buildings.	£	s.	d.
Power house	750	0	0
Nut store and splitting house	1160	0	0
Oil mill, packing shop, and store	1050	0	0
Fibre mill	4500	0	0
	£7460	0	0

Power Plant.	£	s.	d.
4 Boilers, with grates for refuse, with pumps erected	2622	0	0
1 Steam engine, 100 H.P.			
1 do. do. 200 H.P. (erected on concrete foundations) ...	1465	0	0
Steam pipes, valves, etc.	390	0	0
Steel chimney, erected	750	0	0
	£5227	0	0

Copra Mill and Oil Mill.	£	s.	d.
Drying plant	800	0	0
Oil store tank—erected	240	0	0
2 Splitting machines			
1 Copra bin			
5 Sets of elevators			
2 Conveyors			
1 Magnetic separator and dynamo			
1 Set of cage presses			
1 Cake breaker			
1 Set of breaking rolls			
1 Kettle and moulding machine			
4 Plate presses	4420	0	0
1 Paring machine, with grinder			
1 Set of valves			
1 Foundation tank			
Accumulators			
Oil pumps and pipes			
Clarifying tank			
1 Filter press			
Shafting, pulleys, belting, etc.			
Foundations and erection			
	£5460	0	0

Fibre Mill.	£	*s.*	*d.*
Soaking tanks; 6 at £40	240	0	0

Fibre Extracting Plant.

5 Husk crushing mills			
44 Fibre extracting machines			
5 Special do. do.	2902	0	0
5 Willowing machines			
(erected on concrete foundations) ...			
	£3142	0	0

Yarn and Cabling Plant.

45 Spinning machines			
6 Special machines			
7 10-spindle machines			
27 Cabling machines, 2 fold			
9 do. do. 3 folds			
6 do. do. 6 folds			
Bobbins, combs, hackles, etc.			
(erected complete)	£4803	0	0

Rope-Making Plant.

2 Compound rope-laying machines, 4 yarns per strand			
1 Compound rope-laying machine, 6 yarns per strand			
4 Closing machines			
6 Stranding machines			
2 Rope coilers			
(Erected on suitable foundations, with shafting, etc.)	£2768	0	0

ESTIMATE OF COSTS, ETC., COMPLETE. ONE DAY'S WORK—50,000 NUTS

TO	£	s.	d.	BY	£	s.	d.
50,000 nuts at $40 per 1000	233	6	8	Products—			
Oil extraction, as on page 77 ...	13	3	6	7·5 tons cocoanut oil at £40	300	0	0
Fibre extraction, as on page 78...	34	0	0	4·2 tons oil cake at £7 ...	29	8	0
Interest on first cost of plant and buildings at 5 per cent. [buildings, say, £8000; plant, say, £15,000 (yarn and rope plant omitted)]	3	16	8	0·84 tons short fibre at £20	16	16	0
				2·76 tons long fibre at £22	60	14	0
				8·4 tons mattress and spinning fibre at £9 ...	75	12	0
Depreciation, buildings and plant, all at 10 per cent. ...	7	13	4				
Superintendence	10	0	0				
	302	0	2				
Add cost of packages, etc. ...	40	0	0				
Freight	36	0	0				
Dock charges, commissions, etc.	25	0	0				
Total costs	403	0	2				
Profit	79	9	10				
	£482	10	0		£482	10	0

Estimated profit—£79 9*s.* 10*d.* per working day, or over £23,000 per annum.

In the above estimates three hundred working days are assumed as being one year, so that the profit is practically 100 per cent. per annum on the actual cost of the plant and buildings.

CHAPTER IX

CATCH-CROPS

Coffee Robusta (a Paying Catch-Crop)

Coconut cultivation, till it reaches the revenue stage, entails a trial of faith and patience which few care to undergo, except those on the spot already engaged in the industry.

During the waiting years, therefore, much additional interest and occupation is given in the planting of robusta coffee as a catch-crop. It is very profitable and does not appear to interfere with the permanent cultivation at all.

"**Coffee Robusta and Coffee Liberica.**—Robusta differs in many ways from the well-known liberica. The habit is somewhat different. Robusta grows more rapidly. An eight months old robusta plant is much larger and has more branches and leaves than a year old liberica. The branches of robusta are longer and have a tendency to bend down toward the ground, so that the bush is rather umbrella-shaped. Gourmandizers and suckers are fewer than on liberica; the leaves are a lighter green, thinner, and larger in size.

"Robusta bears more berries in a cluster than

COFFEE ROBUSTA, SHOWING FRUIT BERRIES.

[*To face page* 82.

liberica, often over sixty; they are much smaller, but the beans are almost as large, the skin being thinner. On an average *ten piculs of liberian berry give one picul* (133⅓ *lbs.*) *of market coffee.* On the other hand, only four piculs of robusta berry are required for a picul of market coffee. Though many more berries go to a picul than in liberica the greater number in a bunch makes the picking if anything cheaper.

"**Productivity of Robusta.**—Plants about eight months old begin to show flower buds, but a number of these early flowers may not develop into berries, and no concern need be felt if they do not, as, unlike liberica, all later flowers set.

"The plant blossoms the whole year through, and no loss will occur from 'windfall' if berries are collected once a month.

"About ten months are required for the berries to come to maturity; when most of them in a cluster are straw-coloured they may be picked—as a rule the whole cluster may be gathered. A small crop can be collected in the second year, and in the fourth year practically the maximum crop is obtained. From that time onward the yield is fairly uniform. The following figures give the production on an estate in Java planted 10 feet by 10 feet, with forty-five nutmegs taking the place of coffee, that is 390 plants to the acre.

2nd year = 1 picul = 133⅓ lbs. (nearly) per acre.
3rd „ = 6 „ = 800 lbs. per acre.
4th „ = 14 „ = 1866 lbs. „
5th „ = 14 „ = 1866 lbs. „

"In Java it was at first urged against robusta that its fecundity would not continue, but it is now seen that nine-year-old plants are as vigorous and yield as much (and more) as they did when they were four years old.

"**Soil Suited for Robusta.**—The root development of robusta is comparatively rapid and intense. If a young robusta plant is pulled up it will be found to have a mat of fine rootlets, considerably more than a liberian plant of the same size would show. It is easily understood, then, that it thrives best in a loose clay soil, somewhat sandy for preference.

"In peaty land experience has already shown that it does not thrive, at least where the peat is deep and badly drained. It behaves just as other plants do when they suffer from acidity in the soil; robusta, however, is more sensitive. The acidity of such soils must be removed by good drainage and a liberal application of lime. The quantity of lime required will vary with the acidity, which must be tested from time to time. It is now proven that by such treatment coconuts can be made to thrive, and no doubt robusta would too. Coffee canephora, which is equally prolific, would probably do better in such land.

"**Nursery.**—This should be made on virgin jungle soil and level land. It should not be made among coconuts of more than a year old. The nursery plants grown in the shade of trees become white, and the growth is poor.

"The beds should be about 4 feet wide with a furrow of 2 feet between. The seeds should be just covered with fine mould and may be put in 6 inches to 10 inches apart according to the length of time the young plants are to be kept before transplanting. The shade should be about 6 feet high, and gradually removed until the plants are fully exposed when they have four pairs of leaves. This is a suitable stage for planting out.

"A kati is about two thousand seeds. (1 kati = $1\frac{1}{3}$ lbs.)

"**Distance of Plants apart.**—If put down as a permanent cultivation of coffee only, the best distance is 12 feet by 12 feet, with an additional plant in quincunx, which gives six hundred to the acre.

"Interplanted among *coconuts*, which are 30 feet by 30 feet, the coffee should be 7 feet apart and 8 feet from the coconuts; three rows can be put in, and in such way along both lines that the coconut tree stands in a square of coffee 8 feet inside.

Cultivation

"**Planting out.**—Seed at stake, young plants or year-old stumps may be used. A stump, since

it has a certain amount of reserve in it, will probably beat seed at stake put down at the same time, and for this reason is to be preferred. Stumps are not available in the F.M.S., and the planter should put in young plants with four or five pairs of leaves, or failing that, seed at stake, in which case it is probably safer to germinate the seeds first, but they should be put out as soon as the shoot shows, and great care taken to see that it is not broken.

"The usual enemies of other cultivation at stake will, of course, attack coffee put out in the field as seed. The seeds should be covered very slightly, and well shaded by palm leaves or ferns. If ferns are put in green they will curl up and become useless.

"Seed at stake is undesirable in hilly land, as much of it is liable to be swept out of place or covered up so deep in detritus that it is unable to send its young shoots above ground. Putting out young plants is in every respect much safer and better. If the planter has to start with seeds he will lose nothing in growth or otherwise by starting them in a nursery. When transplanting, the lateral roots may be trimmed or left alone, but the soil must be pressed fairly firmly round the root. When left loose it cannot retain moisture, and the young plants fail if a drought comes on after planting out.

"**Weeding.**—Robusta must be kept absolutely clean-weeded. Hand weeding is best. Where

the changkol is used, the coolie is apt to wound the lower part of the stem, which encourages the growth of unnecessary branches; these take away nourishment required elsewhere, and, if they appear, they should be cut off as soon as possible. A good digging or forking over the ground at the end of the second year would be beneficial; it should certainly be done in the third.

"**Pruning.**—The plant tends to form only primary branches. It should be topped at a height of 8 feet, to give a thicker branching by forcing out secondary branches which bear as well as the primaries. Less pruning is required than with liberica, but it must be commenced earlier. Young shoots, due to injuries suffered during weeding, arise near the ground on plants of six months and older, and must be cut off early. As a catch-crop most of it is to be collected in a few years, therefore the drastic prunings taking away half the foliage of the tree, which are now administered to interplanted liberica every nine months or more, must be avoided. Pruning should be done with a sharp knife, and not by plucking.

"**Preparation for the Market.**—Except on a few estates all the coffee at present grown in the F.M.S. is sold in the berry to Chinese. The individual Chinese purchaser, or often two or three working together, prepares by hand-machines all he buys. The European planter,

who looks upon his liberica as of little consequence, finds it pays him better to sell the collected berries than to run his old coffee machinery for such small quantities as he can gather at irregular intervals. Where relatively large areas are under robusta it will no doubt be found most profitable to put down sufficient plant to treat the berries on the estate. It is desirable from another point of view that the product should not be done in the rough way the Chinese follow. The present Malayan output of coffee is probably all consumed locally. Besides planting robusta as a catch-crop many planters are seriously, and perhaps wisely, considering the advisability of devoting part of their acreage to it alone.

"The berry is much smaller than that of liberica, and the pulper used for the latter will be found to be unsuitable. A small Lidgerwood pulper is the best. Hr. van Lennep states in a recent number of the 'Culturgids' that the beans must be fermented for thirty-six hours after pulping, and after being well washed, turned wet into the drying house to dry as quickly as possible at a high temperature. The guardiola dryer is especially suitable. While in the drying house the coffee must be often moved so as to get a regular drying. Coffee so prepared and dried keeps its bluish colour long and has a good flavour.

"**Robusta in the Market.**—Reports from the

home market show that it must be heated and ground in a manner somewhat different from other coffees, and that as to quality, experts are inclined to put it nearly on a level with best Santos. At present the price ranges from $18 to $25 a picul = £2 2*s.* to £2 18*s.* 4*d.* per 133⅓ lbs.

"**Pests of Robusta.**—Robusta has up to the present shown itself fairly free from parasites, but it can hardly be expected to remain so.

"Grown side by side with liberica at Kuala Lumpur, it is almost, but not quite, free from leaf disease.

"As regards insect pests, it is probably as liable as liberica, if not more so, to their attacks.

"**Robusta as a Catch-crop in Coconuts.**—Many soils, especially on hard-backed steep hills, are not over fertile, and it is probable that it is the best in the long run to bring coconuts into bearing without catch-crops, which all compete with the principal crop and remove a certain amount of available plant food. But many private owners, small syndicates, and even companies cannot wait six years for a return. A desirable catch-crop should be a crop yielding a good profit; it should not be too severe on the soil; it should bear early; it should admit of weeding so as to leave the land in a clean condition when it is taken out.

"Tapioca has been tried and is hardly a success;

in fact, it is quite undesirable, Apart from the possibility, at present prices, of its yielding a very small profit, if any, it is so difficult to weed that a large amount of lalang gets in, and the land is in a decidedly dirty condition when the crop is removed. Camphor allows the land to be kept clean, but the time to wait for a crop is too long, and then the profit is not much. *Coffee robusta offers by far the best catch-crop.* A small return will come in the second year, and a good one in the third and following years.

"Therefore, for those who must put down a catch-crop it is undoubtedly the best. The production of robusta costs less per picul than liberica. The total cost of production should not exceed $12 = £1 8*s.* a picul, which returns a net profit of $6 = 14*s.* a picul on an average selling price of $18 = £2 2*s.* a picul. Planted as a catch-crop in the way already recommended, *i.e.* about 1000 to the acre, a return of 10 piculs per acre of market coffee ought to be obtained by the end of the fifth year. This would yield a net profit of $60 = £7 per acre, or over double that at 1913 prices.

"These figures are conservative, judging by the example already given from Java. In the F.M.S. we have not sufficient data on which to base close estimates; but it is evident that, if the entire capital cost of the principal crop cannot be recovered, at least from the end of the second year, it can be more than upkept from the profits on robusta.

"It must be remembered that the cost of planting the coffee has to be added to the cost of bringing the palm into bearing, but, on the other hand, owing to the earlier shade, the weeding will cost less than in coconuts alone.

"With a main crop interplanted with liberica, it is a common fault to let the coffee practically die out, but it should be remembered that as large robusta of five years old is a serious competitor in the soil, it should be ruthlessly cut out as soon as the branches of the coconut trees meet, and in any case in the beginning of the sixth year.

"Planters who wish to know where robusta seed can be obtained should communicate with the Department of Agriculture, Kuala Lumpur." (Extract from Bulletin No. 7. Director of Agriculture, F.M.S.)

Coffee Robusta as a Catch-Crop

(Extract from Report by F.M.S. Inspector of Coconuts.)

"When the soil is alluvial and sufficiently above sea level, robusta coffee, as a catch-crop, should be planted at the same time as the coconuts.

"This coffee grows very well under coconuts for a considerable period, and on rich soil, the return from the crops after the third year may prove sufficient for the entire upkeep of the plantation, as the yield should be from three to

five piculs per acre. The coffee, which may be planted out 7 feet apart, does not to any appreciable extent interfere with the growth of the coconuts, provided the plantation is well maintained.

"Another system, provided the soil is suitable and there is a good demand for the produce, is to put in fruit trees, planted quin-cunx, at the same time as the coconuts. Mangosteen, bananas, rambutans, chiku, and many others, thrive very well when planted out in the way indicated, and, as the trees mature, add considerably to the earnings of the plantation.

"Rubber trees should on no account be interplanted with coconuts, as they cannot possibly thrive well together."

YOUNG COCONUTS AND PARA RUBBER. [*To face page* 92.
(Note space and large drain separating crops.)

APPENDIX

GENERAL INFORMATION AND PLANTATION TABLES

Land Terms in the Federated Malay States

The premium varies from $2 to $3 per acre, according to road frontage. The annual quit rent for the first six years is $1 per acre, and afterwards on first-class land $4 per acre, but if planted up with coconuts only, the owner of the plantation is allowed a rebate of $2 per acre. For blocks up to 640 acres, planting must be commenced within a year from the time the grant is obtained, or from the time of occupation, whichever comes first, and a quarter of the area must be brought into cultivation within five years therefrom. On these two conditions being complied with, the title may be endorsed by the resident as being free of cultivation conditions.

Johore Terms.—The land laws of Johore are based on those ruling in the Federated States, but the terms are more favourable. They are—

Premium per acre for land with road frontage, $3.

Premium per acre for land without frontage, $2.

The quit rent being 50 cents = 1*s.* 2*d.* per acre per annum for the first six years; thereafter, $2.50 per acre per annum, = 5*s.* 10*d.*

* * * *

TABLE SHOWING APPROXIMATE RUBBER YIELD PER ACRE.

Distance.	Number of trees per acre.	½-lb. per tree.	1-lb. per tree.	1½-lb. per tree.	2-lb. per tree.	3-lb. per tree.
Feet.		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
10 × 10	435	326	435	652	870	1305
10 × 15	290	217	290	435	580	870
15 × 15	193	145	193	289	386	579
15 × 20	145	109	145	217	290	435
20 × 20	109	82	109	163	218	327
20 × 25	87	65	87	130	174	261
25 × 25	70	52	70	105	140	210

TABLE SHOWING THE PRODUCING CAPACITY OF RUBBER PLANTATIONS.

Acreage.	At 1 cwt. per acre.	At 2 cwt. per acre.	At 3 cwt. per acre.	At 4 cwt. per acre.
	Tons.	Tons.	Tons.	Tons.
100	5	10	15	20
250	12½	25	37½	50
500	25	50	75	100
1,000	50	100	150	200
10,000	500	1,000	1,500	2,000
50,000	2,500	5,000	7,500	10,000
100,000	5,000	10,000	15,000	20,000
200,000	10,000	20,000	30,000	40,000
350,000	17,500	35,000	52,500	70,000

Table showing Percentage of Profit.

On rubber property at varying capital costs per acre on a yield of 300 lbs. of rubber per acre, at 1/2, cost of production and freight, selling charges and London management:—

[H. K. Rutherford, in *India Rubber Journal*, Quarter Century Number.]

Cost of estate per acre.			Selling price of rubber per pound.									
			At low scale.									
			1/6	1/8	1/10	2/-	2/2	2/4	2/6	2/8	2/10	3/-
£	s.	d.	Profit per cent. on capital cost.									
250	0	0	2	3	4	5	6	7	8	9	10	11
125	0	0	4	6	8	10	12	14	16	18	20	22
83	6	8	6	9	12	15	18	21	24	27	30	33
62	10	0	8	12	16	20	24	28	32	36	40	44
41	13	4	12	18	24	30	36	42	48	54	60	66
31	5	0	16	24	32	40	48	56	64	72	80	88
20	16	8	24	36	48	60	72	84	96	108	120	132

Cost of estate per acre.			Selling price of rubber per pound.					
			At bigh scale.					
			3/6	4/-	4/6	5/-	5/6	6/-
£	s.	d.	Profit per cent. on capital cost.					
250	0	0	14	17	20	23	26	29
125	0	0	28	34	40	46	52	58
83	6	8	42	51	60	69	78	87
62	10	0	56	68	80	92	104	116
41	13	4	84	102	120	138	156	174
31	5	0	112	136	160	184	208	232
20	16	8	168	204	240	276	312	348

EXPORT DUTIES ON CATCH-CROPS, ESTATE PRODUCTS, ETC.

Ceylon	coffee, tea, cocoa	—	per cwt. 10 cts.
,,	cinchona	—	per cwt. 5 cts.
F.M.S.	coffee *	when prices are below $22 per picul	free
,,	do.	$22 up to $24 per picul	1% ad. val.
,,	do.	$24 up to $26	1½% ,, ,,
,,	do.	$26 up to $28	2% ,, ,,
,,	do.	when above $28	2½% ,, ,,
,,	gambier	—	15 cts. per picul
,,	pepper	—	30 cts. por pioul
,,	sugar	—	1% ad. val.
,,	sugar cane	—	1 ct. per picul
,,	tapioca	—	2½% ad. val.
,,	coconuts, copra, coconut oil	—	1½% ad. val.

EXPORT DUTIES ON RUBBER.

F.M.S.	cultivated rubber	—	2½% ad. val.
,,	Para rubber latex	except Pahang	2½% ,, ,,
,,	gutta percha	grown on alienated land	2½% ,, ,,
,,	do.	otherwise	80% ,, ,,
B.N. Borneo	cultivated	—	free
,,	wild	—	10% ad. val.
,,	gutta percha	red and white	10% ,, ,,
Sarawak	indiarubber	—	$10 per picul
,,	gutta jelutong	—	$1 ,, ,,
,,	,, Jangkar	—	$1.50 ,, ,,
,,	,, all other	—	$10 ,, ,,
Zanzibar	rubber	—	15% ad. val.
N. E. Rhodesia	wild rubber	—	4d. per lb.
Nyassaland	,, ,,	—	9d. ,, ,,
Uganda & B.E.A.	,, ,,	—	10% ad. val.
British Guiana	rubbor and balata	from Crown lands	2 cents. per lb. (royalty)

* Coffee: the duty on "parchment" coffee is caloulated on two-thirds of the gross weight and on "dry cherry" on one-third of the gross weight.

The Stock Exchange Quotations

The Stock Exchange Committee will grant a "Quotation" in the shares of a company which is considered by the Committee to be of sufficient magnitude and importance to be entitled to a place on the official list, and also provided the constitution of the company is in accordance with the usages of the Stock Exchange thus—

A company whose subscribed capital is less than £75,000 is not considered of sufficient magnitude to warrant its shares being quoted on the list.

Unless at least two-thirds of the nominal capital proposed to be issued be subscribed for by the public the company will be ineligible for a quotation.

The articles of the company must meet the requirements of the Stock Exchange on the following points, viz:—

Restraining the directors from employing the company's funds in the purchase of its own shares

Securing the qualifications of directors.

Limiting the amounts and intervals of calls.

Limiting the borrowing powers of the Board.

That every member shall receive one share certificate free of charge, and that the charge for a certificate in place of one worn out or lost not to exceed one shilling.

That members holding one-tenth of the issued capital shall have power to requisition an extraordinary meeting.

That unclaimed dividends must not be declared forfeitable.

That fully paid shares shall be free from all lien.

That printed copies of the annual report and balance sheet be sent to members seven days before the meeting.

That the articles must not contain a clause relieving the directors from the duty of enquiring into the authenticity of transfers.

Companies making an agreement with vendors for the guarantee of a dividend, or with contractors for the payment of interest during construction, the Committee object to.

Companies whose securities are quoted on the official list should forward to the Share and Loan department copies of all circulars relating to meetings, calls, new issues, etc., and notice of any proposed dividend.

* * * * *

TREES PER ACRE AT DIFFERENT PLANTING DISTANCES.

ft.	8	10	12	13	14	15	16	17	18	20	25	30	35	40
8	680	546	453	418	388	363	340	320	302	272	217	181	155	136
10	546	435	363	335	311	290	272	256	242	217	174	145	124	108
12	453	363	302	279	259	242	226	213	201	181	145	121	103	90
13	418	335	279	257	239	223	209	197	186	167	134	111	95	83
14	388	311	259	239	222	207	194	186	172	155	124	103	88	77
15	363	290	242	223	207	193	181	170	161	145	116	96	82	72
16	340	272	226	209	194	181	170	160	151	136	108	90	77	68
17	320	256	213	197	186	170	160	151	142	128	102	85	73	64
18	302	242	201	186	172	161	151	142	134	121	96	80	69	60
20	272	217	181	167	155	145	136	128	121	108	87	72	62	54
25	217	174	145	134	124	116	108	102	96	87	69	58	49	43
30	181	145	121	111	103	96	90	85	80	72	58	48	41	36
35	155	124	103	95	88	82	77	73	69	62	49	41	35	31
40	136	108	90	83	77	72	68	64	60	54	43	36	31	27

Federated Malay States Railway.

Distance by Rail from Singapore.

Names of stations.	Distances.	1st class fares.
Johore Bharu	16 miles	... $ 1-30
Gemas	136 ,,	... 8-62
Tampin	169 ,,	... 10-60
Malacca	190 ,,	... 11-86
Seremban	199 ,,	... 12-40
Kuala Lumpur	245 ,,	... 15-16
Kuala Kubu	284 ,,	... 17-50
Tanjong Malim... ...	299 ,,	... 18-40
Tapah Road	342 ,,	... 20-98
Ipoh	375 ,,	... 22-96
Kuala Kangsar	409 ,,	... 25-00
Taiping	428 ,,	... 26-14
Parit Buntar	464 ,,	... 29-68
Prai	487 ,,	... 29-68

Distance by Sea.

Singapore to Penang	370 Miles
Singapore to Malacca	118 ,,
Singapore to Dindings	291 ,,
Malacca to Penang	251 ,,
Penang to Dindings	78 ,,
Penang to Butterworth	1½ ,,
Penang to Prye River Dock	2¾ ,,
Round Singapore Island	66 ,,
Round Penang Island	44 ,,

Horizon—Distance at various heights :—

Height, feet.	Distance, miles.	Height, feet.	Distance, miles.
5 ...	3⅛	500 ...	32
10 ...	4½	1000 ...	45
30 ...	7¾	2000 ...	63
50 ...	10	3000 ...	78
100 ...	14	4000 ...	90

* * * * *

Area of British Malaya	...	51,725 square miles.
,, Straits Settlements ...	...	1,560 ,, ,,
,, Federated Malay States	...	26,380 ,, ,,
,, Unfederated Malay States	...	23,785 ,, ,,

Trade of—	Total imports.		Total exports.
Straits Settlements in 1911 ...	£46,437,349	...	£39,887,146
Federated Malay States in 1911	7,761,904	...	13,562,774
	£54,199,253		£53,449,920
Straits Settlements in 1912...	£52,504,551	...	£43,765,022
Federated Malay States in 1912	8,880,979	...	18,080,323
	£61,385,530		£61,845,345

Population of—	
British Malaya	2,651,036 *
Straits Settlements	714,069
Federated Malay States	1,036,999
Unfederated Malay States	899,968

RAINFALL—QUANTITY OF WATER PER ACRE.

1 inch in depth rainfall per acre { = 3630 cubic feet. = 22622·523 imp. gallons. = 101·28 tons.

or

1 inch rainfall in 24 hours = 2·52 cubic feet per minute.

SOILS—ABSORPTION OF MOISTURE FROM THE AIR.

Sandy clay ...	26 tons per acre	= 0·256	inches of rainfall.
Loamy clay ...	30 ,, ,,	= 0·296	,, ,,
Stiff clay ...	36 ,, ,,	= 0·355	,, ,,
Garden mould or nurseries	45 ,, ,,	= 0·444	,, ,,

SPACE OCCUPIED BY ONE TON OF DIFFERENT MATERIALS.

1 Shipping Ton Merchandise	40 c. feet.
1 Shipping Ton Timber	42 c. feet.
1 Ton displacement of a Ship	35 c. feet.
1 Ton Water for Ships	210 gals.
1 Ton Welsh Coal	40 c. feet.
1 Ton Newcastle Coal	43 c. feet.

* White population = about 1 per cent.

European Measures Compared with English Mile.

English Mile	1760 yds.
English Geographical Mile	2024 ,,
Kilometre	1093 ,,
German Mile	8114 ,,
Russian Verst	1167 ,,
Austrian Mile	8297 ,,
Dutch Ure	6086 ,,
Norwegian Mile	12357 ,,
Swedish Mile	11693 ,,
Danish Mile	8240 ,,
Swiss Stunde	5257 ,,

1 Hectare = 2·471 acres.

Land Measure—Imperial Statute.

1 link	...	= 7·92 inches. = 0·66 foot. = 0·22 yard.
1 foot	...	= 1·51 links.
1 yard	...	= 4·54 links.
1 chain	...	= 792 inches. = 66 feet. = 22 yards.
1 mile	...	= 1760 yards.
1 mile	...	= 80 chains.
1 square mile		= 640 acres.
1 acre	...	= 43560 square feet.
1 acre	...	= 4840 square yards.
1 acre	...	= 10 square chains.

Bouw—Dutch land measure = $1\frac{3}{4}$ acres.

SCALES OF MAPS AND PLANS.

Chains to 1 inch.	Inches to 1 mile.	Sub-multiple of actual length.
1	80·0	792
2	40·0	1584
3	26·6̇	2376
4	20·0	3168
5	16·0	3960
6	13·3̇	4752
7	11·42571	5544
8	10·0	6336
9	8·8̇	7128
10	8·0	7920
11	7·2̇7	8712
12	6·6̇	9504
13	6·1̇53846	10296
14	5·7̇14285	11088
15	5·3	11880
16	5·0	12672

NUMBER OF PLANTATIONS IN THE STRAITS SETTLEMENTS AND MALAY PENINSULA, UNDER EUROPEAN CONTROL (*vide* STRAITS ESTATES DIRECTORY).

	Estates.
Rubber, principally Hevea Braziliensis ...	420
Coconuts	110
Coffee	40
Sugar	10
Tapioca	10
Gambier, Camphor	6
Pineapples, Rice	30
Total	626

NOTE.—This does not include native holdings.

Measures of Surface.

144 Square Inches = 1 Square Foot.
9 Square Feet = 1 Square Yard.
30¼ Square Yards = 1 Sq. Pole or Perch.
40 Perches = 1 Rood.
4 Roods = 1 Acre.
640 Acres = 1 Square Mile.

Water Measure.

1 Gallon = 10 lbs.
1 Cubic Foot = 62·321 lbs.
or 6·232 gals. = about 6¼ gals.

Useful Notes.

French Kilo	2·204 lbs.
50 Kilo	110¼ lbs.
Tonneau	2204·6 lbs.
1 Franc (the Exchange value varies of this)	10*d.*
25 Francs	£1
German Mark, ditto	1*s.*

1 Cub. foot Iron Cast, weighs 450 lbs.
1 ,, Gold ,, 1,210 ,,
1 ,, Platinum ,, 1,220 ,,
1 ,, Lead ,, 710 ,,
1 ,, Copper ,, 550 ,,

French Measure.

1 Millimetre	0·001 yards.
1 Centimetre	0·01 ,,
1 Decimetre	0·109 ,,
1 Metre	1·093 ,,
Roughly 1 Metre	39½ ins.
Kilometre	1093·633 yards.
1760 Yards	1 mile.

Troy Weight.

24 Grains ... = 1 Pennyweight.
20 Pennyweights = 1 Ounce.
12 Ounces ... = 1 Pound.

Measures of Capacity.

4 Gills ... ... = 1 Pint.
2 Pint ... ... = 1 Quart.
4 Quarts ... ... = 1 Gallon.
2 Gallons ... ... = 1 Peck.
4 Pecks or 8 Gallons = 1 Bushel.
8 Bushels ... ... = 1 Quarter.
36 Bushels ... ... = 1 Chaldron.

Circular Measure.

The Diameter is to the Circumference about as 7 is to 22, or more nearly as 1 is to 3·1416.

The Diameter × 3·1416 gives the circumference.

The Radius squared × 3·1416 gives the Area.

The Diameter squared × 3·1416 gives the Area of a Sphere or globe.

One-sixth of the Cube of the Diameter × 3·1416 gives the Solidity of a Sphere.

A Circular Acre is 235·5 feet, a Circular Rood 117·752 feet in diameter.

Cubic or Solid Measure.

Shipping Ton = 40 Cubic Feet merchandise.
Shipping Ton = 42 Cubic Feet of Timber.
Displacement of a Ship 1 ton = 35 Cubic Feet water.
1,728 Cubic inches = 1 Cubic Foot.
27 Cubic Feet = 1 Cubic Yard

Hay and Straw Measure.

Truss of Straw	36 lb.
Truss of Old Hay	56 lb.
Truss of New Hay (to Sept. 1st)...	60 lb.

Load, 36 Trusses = Straw, 11 cwt., 2 qrs. 8 lb.; Old Hay, 18 cwt.; New Hay, 19 cwt., 1 qr., 4 lb.

Apothecaries' Fluid Measure.

60 Minims (drops) = 1 Fluid Drachm.
8 Drachms ... = 1 Ounce.
20 Ounces ... = 1 Pint.
8 Pints ... ... = 1 Gallon.

Avoirdupois Weight.

16 Drams ... ... = 1 Ounce.
16 Ounces ... ... = 1 Pound.
14 Pounds ... ... = 1 Stone.
2 Stones or 28 lbs. ... = 2 Quarters.
4 Quarters or 112 lbs. = 1 Hundredweight
100 Pounds ... ... = 1 Cental.*
20 Hundred-weight ... = 1 Ton.

* *Used for buying and selling Corn.*

Sundry Weights.

1 Picul = 133⅓ English lbs.
1 Picul = 61·76125 Kilos.
1 cwt. = 50·84 Kilos.
1 Kilo. = 2·203 lbs.
1 Maund = 80 lbs.
1 Kandy = 560 lbs.

Piculs—Ton.

1 Cattie = 1⅓ lbs.
133⅓ lbs. = 100 Catties or 1 Picul.
16·8 Piculs = 1 ton.
1 Ton = 2240 lbs.

THE COCONUT INDUSTRY IN THE WEST INDIES

SINCE the first portion of this manual was written the author has had the opportunity of visiting about twenty coconut plantations in the West Indies, and the study of the cultivation in these parts is most interesting.

In selling his produce the planter has here a decided advantage over his distant competitor of the Middle East and the Dutch Archipelago, for the reason that America, which is the greatest consumer of the nut, is but a week's journey from the plantation. This admits of the nut being shipped whole, though free of husk, and it is considerably more profitable to the planter than as if sold as copra or in desiccated form. The American import duties and freight on coir or fibre prevent shipments in husk, and at present the value of this important product is lost to both buyer and seller. In the West Indies no attempt is made to convert the husk into marketable fibre, and this loss may be more fully realized when it is shown that the husk from 70,000 nuts produces 30 tons of fibre,

costing £4 per ton to prepare, and selling for at least £9 per ton, the initial cost of the factory equipment being about £3000.

West Indian nuts are much smaller than those of Malaya or Venezuela, which is largely accounted for by lack of proper cultivation, want of manure, and above all, the absence in earlier days of any care in the selection of seed nuts. It is a generally accepted fact that nuts which fell below the market standard of requirement were put into the nursery.

Again, the world-wide drought of 1910–1911 has had a marked effect on the cultivation, and has increased considerably the percentage of small nuts.

According to size, the nuts are of three classes, known as Selects or Standards, Culls, and Rejects. An iron ring, $3\frac{3}{4}$ inches in diameter, is the size tests for Selects; for Culls, $3\frac{1}{4}$ inches; and the smallest, which pass these rings, are the Rejects. At one time the American markets only bought Selects. They are now glad to purchase Culls as well, with but slight difference in price. The Rejects are made into copra on the plantation, and where machinery is available, this is pressed into oil.

From evidence obtained, it would appear that the average proportion of Selects, Culls, and Rejects is as follows :—

Selects or Standards, 50 per cent.; Culls, 30 per cent.; Rejects, 20 per cent.

Given better cultivation, these averages would

certainly be changed to 80 per cent. Selects and 20 per cent. Culls.

It behoves the West Indian planter, therefore, to be content with lower dividends until a higher state of cultivation is obtained.

Scarcity of labour is mentioned as the great drawback, but this difficulty is surely not insurmountable. The mere mention of the introduction of Chinese labour raises innumerable objections, the principal being that it was tried seventy years ago and failed. Also, that the Chinaman's aim is to be a shop-keeper. To this there can be no objection, provided the Chinese coolie has complied with his labour contract for the stipulated period of service. The Coolie Indenture Ordinance provides ample security in this respect. There would, of course, be much local opposition to overcome; but where an ideal country is handicapped in the pursuit of Tropical Agriculture by lack of vigorous labour, something should be done to secure adequate conditions.

The influx of a few thousand Chinese coolies would do much to remove the peculiar indifference to work which is here met with, and, at the same time, be a gain to the country, for the Chinaman is hardworking, domesticated, and very law-abiding.

Concerning the question of disease, it is unfortunate that the Government appears to be powerless to enforce the provisions of the Plant Protection Ordinance, which makes it compulsory

for all property owners having diseased coconut trees to destroy them at once; this has not hitherto been done. The chief difficulty appears to be the lack of funds to carry out the work of destruction required by the law. Such expense, however, becomes a first charge on a plantation, and the initial fund to start operations should be an immediate concern of the Government Treasury.

Apart from the existing official Agricultural Boards, a West Indian Planters Association, with branches throughout the islands, would be a useful institution.

In important districts co-operation is needed amongst planter owners for securing to themselves a resident mycologist. He might be allowed to supplement his salary by reporting on other plantations as occasion offers, and thus become thoroughly acquainted with conditions in general throughout the district. It is likely, too, that Government would invest him with authority to deal with disease under the Plant Protection Ordinance.

General Conditions

Climate and Soil.—These are much the same as those prevailing in other tropical countries where the coconut palm is in evidence.

As in Malaya, and the East generally, the palm of the West Indies is the *Cocos Nucifera.*

Seed Nuts.—Great care is now being taken in the selection of seed nuts. Good bearing trees are given a distinctive mark, sometimes in the form of a painted band in red, for the information of the collectors. Some planters are importing specially selected nuts from Venezuela, which is proving successful.

Nurseries.—These, again, are little different from the usual nursery, except that the seed nuts are put in vertically, instead of at an angle of 45 degs. There are many objections to the upright position, one being the unsteadiness of the plant in wind.

Another important reason why nuts in the nursery should not be planted vertically, is that at the top or stalk end there is a depression around the "eyes" or germ seats, in which water is likely to settle and rot the germ. In the oblique position it drains off. For germinating purposes the nut has always a sufficiency of moisture available from within.

The period of germination is about four months, and the Western planter favours transplanting when the leaves are about a foot high. The argument in support of this is that there is less damage from breeze in the nursery, and to roots in the transplanting, and a lower cost of transport.

Bearing Stage.—This, as elsewhere, depends much upon the state of cultivation; under fair conditions the sixth year is the flowering year.

Yield.—These average on good plantations 80 nuts per tree per annum. Some trees in particular give as many as 150 nuts per annum in three pickings.

Maturing.—A good system in practice in the West is the storing of nuts in large sheds, covered with coconut leaves to allow those not thoroughly ripe to mature. The nuts are carted into the shed as they are picked, and allowed to remain there for one or two months in the cool before they are husked.

Picking.—The West Indian method is undoubtedly the best. The native climbs the tree, supported at the waist by a rope loop, which leaves both hands free to pick the nuts, and, at the same time, it enables him to remove moss and lichen from the tree.

A good picker can gather as many as 1200 a day, but to obtain such a figure constant supervision is necessary. On most estates there are three pickings a year, one in every four months.

Diseases

Like all other plants, especially when grown in large numbers in one place, coconuts are liable to diseases caused by parasitic vegetable organisms, fungi, and bacteria. Four such diseases are now well known in the West Indies, while others may eventually be found to occur. Three

PLATE X.

WEST INDIAN METHOD OF CLIMBING COCONUT TREE.

[*To face page* 110.

of them are of considerable importance, but the fourth, only when the trees have become unhealthy from other causes. The diseases are: bud rot, root disease, bleeding stem, and leaf disease. With the exception of root disease, they may be expected to appear on trees of all ages from four years upward. To a casual observer, trees suffering from any of these diseases have much the same appearance. The leaves look yellow and sickly, and the outer ones often hang down round the trunk, while in some cases the tips of the leaflets may be broken and hang downward. Such leaflets are dry and greyish in appearance, and are attached to unhealthy leaves. When trees are clearly in ill health and present the general appearance described above, the question arises as to what is the cause of the disease, and what is to be done to improve the condition of the trees and prevent the spread of infection. They should be examined for indications of the presence of any of the four fungoid diseases, a description of whose general symptoms and treatment follows.

Bud Rot.—On examining an unhealthy tree affected with bud rot, it is usually found that the young central leaves are standing upright and not unfolding as they should; soon afterwards they turn yellow and then brown, while the whole cabbage or central bud has an unhealthy appearance. Sometimes the drying up of the central shoots cannot be observed until

many of the lower leaves have turned yellow or brown, while in a few instances, the outer leaves are the first to appear unhealthy. The disease does not seem to follow any very definite sequence as regards the order in which the leaves are attacked, nor to be very constant in its point of origin, at any rate as it is known in the West Indies. After a time, the terminal bud falls over and the complete death of the tree follows slowly. Frequently, a ring of healthy-looking green leaves is left at the top, and these may continue green for some time after the bud has fallen. On cutting down a tree showing these symptoms, it is found that the bases of the young leaves and of the still undeveloped flower stalks, as well as all the soft tissues at the top of the stem, are affected by a soft brown rot and give off a most unpleasant smell. All the other portions of the tree, the roots and remainder of the stem, will be found to be quite healthy—a feature which distinguishes this disease from root disease or stem bleeding. Furthermore when the youngest visible leaf is observed to have fallen over and wilted, it is almost certain that the bud rot is present.

The cause of this disease is at present uncertain, though several authorities are inclined to attribute it to the presence of bacteria. Although the parasitic organism has not been definitely determined, there is but little doubt that the only safe course to pursue, when the

disease appears in a plantation, is to destroy the infected trees as rapidly as possible. By the time that the outward symptoms make their appearance, the central bud is usually so badly decayed as to preclude the hope that the tree can be saved. The infected trees should be cut down and burned. Other trees in their neighbourhood should be carefully watched for signs of the disease and treated in the same manner when it appears. If it spread to any extent, trees in the infected area might be sprayed thoroughly with Bordeaux mixture. It is believed by some that placing salt inside the cabbage is a protection against this disease, though no definite evidence on the subject is available.

Root Disease.—This is practically confined to trees that have commenced to bear. Its first symptoms are often somewhat similar to those of bud rot, but the two may be distinguished on further examination. The first signs of its presence are shown by the leaves, which become wilted and then turn yellow. Finally they dry up, blacken and hang down from the cabbage, often remaining a considerable time before they are shed. Frequently it is to be observed that the leaves do not hang down, but that the petioles or sheathing bases break across, leaving the sheathing portion on the trunk, while the expanded portion either falls to the ground or hangs down. Usually the outermost ring of leaves is the first to be

affected, though often a middle ring becomes wilted and yellow first, while the leaves outside and inside it are green. After the yellowing of the leaves takes place, diseased trees shed most, if not all, of their nuts, irrespective of their age, while the flowers subsequently produced do not set. Finally, the terminal bud rots and falls over, and the tree dies. The earlier symptoms are exactly like those exhibited when trees are suffering from drought, and in fact are due to lack of water owing to the destruction of the roots. It may, however, be determined whether root disease is actually present or not by making an examination of the roots themselves, and the first two or three feet of the stem. Such an examination quickly reveals a diseased and disorganized condition of the outer tissues of the roots, while, when the tree is cut into, it will be seen that a red discoloration, extending from the ground level for a distance of two or three feet upwards, is present in the stem. This may occur as a ring toward the outside, or a general discoloration of the tissue near the centre of the stem. The death of the roots and the red discoloration of the stem are the two absolutely distinguishing signs of the condition.

The cause of the disease is at present uncertain; but the following remedial measures may be recommended. All infected trees should be cut down, their roots carefully dug up, and the whole burned. The soil from which the tree has been

taken should be given a good dressing of lime and should be well forked over. As a further precaution, the infected area should be isolated by a trench two feet deep and two feet wide, the soil from this being thrown on to the infeeted land. When the trees have been dug out and burned, the land should be allowed to rest for a year, and then supplies should be planted. Attention should be paid to cultivation and drainage on any estate on which root disease makes an appearance.

Stem Bleeding Disease.—The symptoms of this vary somewhat according to the age and nature of the trees attacked. In general, cracks appear on the bark, from which a brown viscid liquid oozes, that soon turns black and leaves a dark stain on the bark. On cutting away the cortex near the crack it is often found that the tissue has decayed and become soft and watery. In some cases the outer layer of tissue falls off, leaving a hole filled with fibres. In other cases spiral cylindrical hollows are formed running up and down the stem; while in extreme cases the whole tree may be rendered hollow to within two or three feet of the terminal bud. This may occur even when only a few bleeding patches are visible externally. The disease does not necessarily cause the death of the tree, and its effect on the crop is usually small, at any rate for a time. Its importance lies principally in the fact that trees, weakened by the presence

of the hollow spaces in their stems, are liable to be broken off in a strong wind. It is much more prevalent in wet weather than in dry. Stem bleeding is caused by a fungus, *Thielaviopsis paradoxa,* which is responsible for a rot of pine-apples and a decay of cane cuttings. Its spread in plant tissues appears to be dependent on the amount of sugar which they contain.

The remedial measures consist of cutting out the infected tissues and burning all chips. The operation is best performed with a chisel and mallet. Slanting wounds should be made, in order that water may run off them. When the diseased portions have been cut out, the surfaces of the tissues should be carefully burned with a torch to dry them, and the wound should then be dressed with tar.

As bleeding stem disease is so prevalent in the West, notches for climbing the tree are strictly avoided. The system in any case is not a good one, and Eastern planters would do well to follow the example set in exercising care over the bark or stem. It should not be subjected to wounds of any kind.

Leaf Disease.—Frequently leaves appear to be dropping, and the tips of the leaflets remote from the stem become greyish in colour. The condition appears to spread gradually to those nearer the stem; when the leaflets have become badly diseased this portion breaks down. An examination reveals the fact that the tips and

many parts of the edges are dry and dead, and there occur small yellowish spots. These appear first on the under sides of the leaves. When a large number have collected it assumes a yellowish appearance and becomes grey and withered. It may remain hanging on the tree for some time, but it finally drops. As a result of the diseased condition of the leaves, the number of nuts diminishes and finally no flowers set. In very bad cases the terminal bud is left alone, and eventually this falls over and the tree dies.

Leaf disease is caused by a fungus known as *Pestalozzia palmarum*. It is found on several other host plants besides coconuts, including tea and seedlings of Para rubber.

The remedial measures consist firstly, of destroying the spores of the fungus and thus preventing its spread; and secondly, of improving the health of the trees by cultivation, drainage, and manuring. To destroy the spores of the fungus, all badly attacked leaves should be cut away and burned, while, as in the case of the other diseases, dead trees should be destroyed. In bad cases it will be found useful to spray both infected trees and those which are healthy with Bordeaux mixture.

Commercial Notes

Germinated seedlings from selected Venezuelan nuts sell at an average price of $40 (Ex. 4*s*. 2*d*.) per thousand ex. plantation.

* * * * *

The average price of nuts delivered to buyer's boat at plantation is approximately as follows:—

Selects or Standards	$32 per thousand.
Culls	$25 ,,

Copra from Rejects is mostly pressed into oil on the plantation, and sells at about 5*s.* per gallon.

* * * * *

The value of Poonac or Residue Meal, as a cattle feed and manure, is equal in value to the factory charges in pressing the relative bulk of Copra into oil.

The Coconut Oil obtained is almost clear profit.

The following is an average scale of working costs:—

Picking	60	cents per 1000 nuts.
Husking	40	,, ,, ,,
Breaking and extracting Copra ...	9	,, ,, 100 lbs. green copra.
Selecting	6	,, ,, 1000 nuts.
Filling, sewing bags, loading, carting on shore from store to boat	10	,, ,, ,,
Collecting in field	40	,, ,, ,,
Carting from field to shore, wear and tear of rolling and live stock	40	,, ,, ,,

Or—From tree to boat $2.00 per 1000 nuts.

An additional $5 should amply cover the costs of Production, Cultivation, Up-keep, Depreciation, and Management Charges, thus making a total All-In cost of $7.00 (£1 9*s.* 2*d.*) per 1000 nuts.

The approximate values of Coconut trees in the West Indies are as follows:—

Full bearing trees	30s. each.
6 to 8 year trees	16s. ,,
3 to 6 ,, ...	4s. ,,
1 to 3 ,, ...	2s. ,,

Compensation for trees removed for mining or public purposes 40s. each.

West India Copra sells at about £28 per ton.

Three good large-sized nuts give 1 lb. of Desiccated Coconut, which sells at about 1s. per lb., the market being America.

Expenditure and Revenue in forming a Coconut Estate of 500 Acres in Trinidad.

By Mr. W. Greig, of Cedros Estates, Trinidad.

PUBLISHED IN OFFICIAL AGRICULTURAL BULLETIN NO. 71.

The following is an estimate of the expense of clearing land and developing, *at the rate of* 100 *acres per year*, a coconut estate of 500 acres in Trinidad. It is of interest to compare it with that for 500 acres in the Federated Malay States, and to note that in the West Indies only about 100 acres per annum can be planted out owing to scarcity of labour.

EXPENDITURE.

1st Year.	£
Cost of land (550 acres at £2 10s. per acre)	1375
Clearing 130 acres at £1 10s. per acre	195
Roads and traces	50
Lining, holing, planting and seed-nuts (100 acres) ...	165
Weeding and cutlassing	150
Draining	25
Stock (5 oxen, 2 cows, 2 horses, 1 cart, stable, pen) ...	300
Labourers' barrack (12 rooms)	300
Dwelling-house	400
Ward rates and taxes	32
Supplies and contingencies	100
Superintendence	200
	£3292

2nd Year.	£
Cultivating 100 acres planted 1st year	175
Maintenance of roads, traces, etc.	25
Clearing 100 acres new land	150
Roads and traces, new	50
Lining, holing, and planting 100 acres new land ...	165
Weeding and cutlassing, new land	150
Labourers' barrack for immigrants (6 rooms)	175
Immigration charges on 12 immigrants	25
Ward rates and taxes	34
Supplies and contingencies	100
Superintendence	200
	£1249

3rd Year.	£
Cultivating 200 acres planted 1st and 2nd years ...	350
Maintenance of roads and traces	50
Clearing, planting, and cultivating 100 acres new land	515
Labourers' barrack for immigrants (6 rooms)	175
Immigration charges on 24 immigrants	50
Ward rates and taxes	35
Supplies and contingencies	100
Superintendence	200
	£1475

4th Year.

	£
Cultivating 300 acres planted 1st, 2nd, and 3rd years ...	525
Maintenance of roads, traces, etc.	75
Clearing, planting, drainage, etc., 100 acres	515
Labourers' barrack for immigrants (6 rooms)	175
Hospital for immigrants	300
Immigration charges on 36 immigrants	75
Stock (1 horse)	20
Ward rates and taxes	36
Supplies and contingencies	100
Superintendence (1 overseer added)	275
	£2096

5th Year.

	£
Cultivating 400 acres, planted first 4 years	700
Maintenance, roads, traces, etc.	100
Clearing, planting, draining, etc., 100 acres	515
Labourers' barrack, for immigrants (6 rooms) ...	175
Immigration charges on 48 immigrants	100
Ward rates and taxes	38
Supplies and contingencies	100
Superintendence	275
	£2003

6th Year.

	£
Cultivating 500 acres, planted first 5 years	875
Maintenance of roads, traces, etc.	125
Clearing 20 acres land for pasture, etc.	30
Labourers' barrack for immigrants (6 rooms)	175
Immigration charges on 60 immigrants	125
Ward rates and taxes	40
Supplies and contingencies	100
Superintendence	275
	£1745

From the sixth year the principal disbursements are connected with general upkeep, gathering, factory, and shipping expenses, the totals of which appear in the following summary:—

COCONUTS—SUMMARY.

Year.	Expenditure.	Revenue.	Expenditure from the 9th to the 12th year, in excess of Revenue.
1st	£3,292	Nil	—
2nd	1,249	,,	—
3rd	1,475	,,	—
4th	2,096	,,	—
5th	2,003	,,	—
6th	1,745	,,	—
7th	1,540	,,	—
8th	1,540	,,	—
9th	1,566	£197	£1,369
10th	1,605	497	1,108
11th	1,680	1,066	614
12th	2,160	2,048	112
13th	2,504	3,523	—
14th	2,522	4,801	—
15th	2,528	5,986	—
16th	2,555	6,948	—
17th	2,611	7,375	—
	£34,671	£32,441	£3,203

At the end of the eighth year the expenditure amounts to £14,940; from the ninth to the twelfth year there is a further expenditure of capital amounting to £3203 before the estate becomes self-supporting.

The actual working capital required for an estate of 500 acres is £18,143, or £36 an acre.

Notes on the Foregoing Estimates and Cultivation in General

The author, when in Trinidad, had the honour of being invited to a meeting of the Local Agricultural Board. He was introduced to about twenty planters from different parts, and in discussing coconuts it was agreed by the majority that with reasonable cultivation the sixth year should be the first fruiting year. Mr. Greig makes it the ninth year, which is conservative. Further, he provides for the planting up of 100 acres only per annum owing to the scarcity of labour. Here, too, the estimate is on the safe side, for, given capital and energy, local opinion estimates that at least 250 acres per annum could be handled. It is understood that these estimates do not allow for stumping or continuous clean weeding, the term "cultivating" meaning the cutlassing and clearing up of planted areas two or three times a year.

The sum of £200 per annum for superintendence is inadequate, and bears out the opinion formed by the author when in the West, namely, that managers and superintendents are insufficiently paid. In one case that came under notice, a manager of an estate valued at a quarter of a million sterling was in receipt of remuneration under £300 per annum. Is there any wonder that some cultivations looked neglected and returns are short?

European or white assistants in the West are

called "overseers," which to a visitor seems a very undignified term, and one that would not be tolerated in the East.

The cutlass in the West is exactly the same agricultural implement as the parang of the East. Innovations are not readily welcomed in the West, but if once the Assam fork gained admittance, it would prove to be a boon to coolie and owner alike. Its advantage over the foot-driven fork would soon be apparent, and a coolie enabled to fork much larger areas than can be done at present.

The disc harrow, too, could be used to great advantage. Oxen power is plentiful, and would require but little training. The question of cutting lateral roots need not cause anxiety. The discs only disturb about nine inches of top soil, and the primary feeders of the coconut lie deeper than that. Even if cut, laterals suffer little therefrom, and it is nothing as compared with the advantages gained from disturbing the surface, thus admitting more plant food, air and moisture.

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